Bravo Drive History

Section 7A - Bravo Drive Unit History

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7 A

1988

- Bravo One introduced on Big Block Magnum and 7.4L models.
- Due to their straight-cut gears, it is a true bi-rotational drive.
- Propshaft rotation changed by changing shift cable output at remote control box and changing propeller.
- Propshaft bearing carrier was shimmed to set propshaft rolling torque.
- No gear lube monitor and no lube passages in driveshaft housing or bell housing.
- Dipstick was in the top cover. Drain plug at front of torpedo. Had to tilt drive unit approximately 45° to allow full drain.
- Fill in vertical position until oil flows out vent plug and verify with dipstick.

1989

- Bravo Two introduced.
- Designed for large, heavy boats with 45 MPH maximum speed.
- Same driveshaft housing as Bravo One, but much larger gear housing.
- Swings a 50.8 cm (20 in.) diameter propeller. Uses TR style prop mounting hardware.
- Load ring on propshaft carrier is used to maintain rolling torque instead of shims.

1990

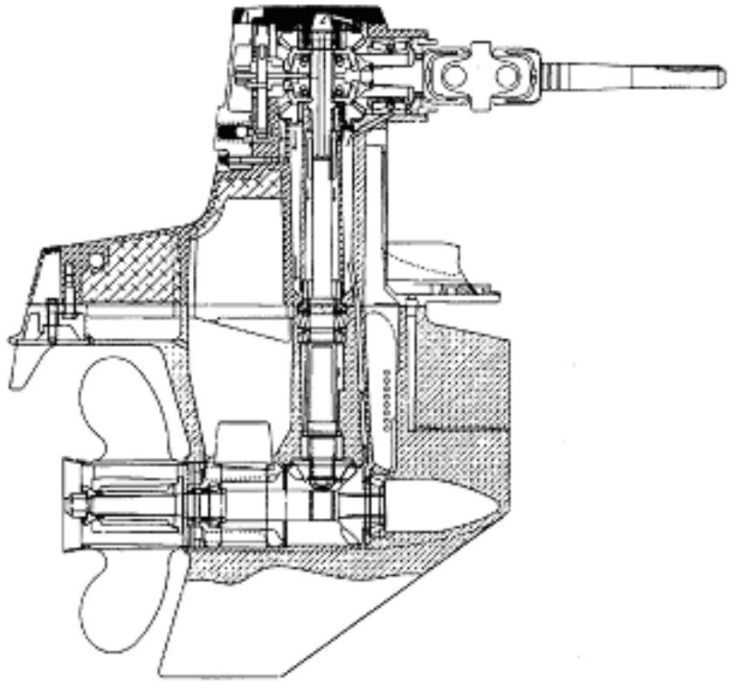
- Bravo One received streamlined gearcase. The strut was moved forward 5 cm (2 in.).
- Bravo One drain plug is now at the rear of the propshaft carrier (C2 carrier).
- Bravo One must trim in fully to drain. Fill in vertical position until oil flows out vent plug.
- Gear lube monitor added to all driveshaft housings and transom assemblies.
- Dipstick removed from top cover.

1991

- Oil recirculation added.
- Lower gearcase pumps lubricant to the U-joint shaft bearings and it returns to the lower gearcase through cast-in passages.
- Required new driveshaft and gear housings. Service Bulletin 91-20.

Bravo Oil Circulation System (1991 and Newer)

Oil movement starts in the gearcase, a high pressure area is created by gear rotation. Using passages cast into the housings this high pressure is directed to the U-joint bearings and seal. Oil; cooled by water flowing past the gearcase, lowers the U-joint bearing and seal temperature. Another passage directs oil from above the U-joint gear to the needle bearing inside the top cover. Oil returns to the gearcase through a passage aft of the driveshaft. Oil enters this return cavity from under the driven gear. A small amount of oil will pass through the bearings under the lower driven gear and around the needle bearing on the upper driveshaft. Oil exits the driveshaft housing and reenters the gearcase through the driveshaft bore.



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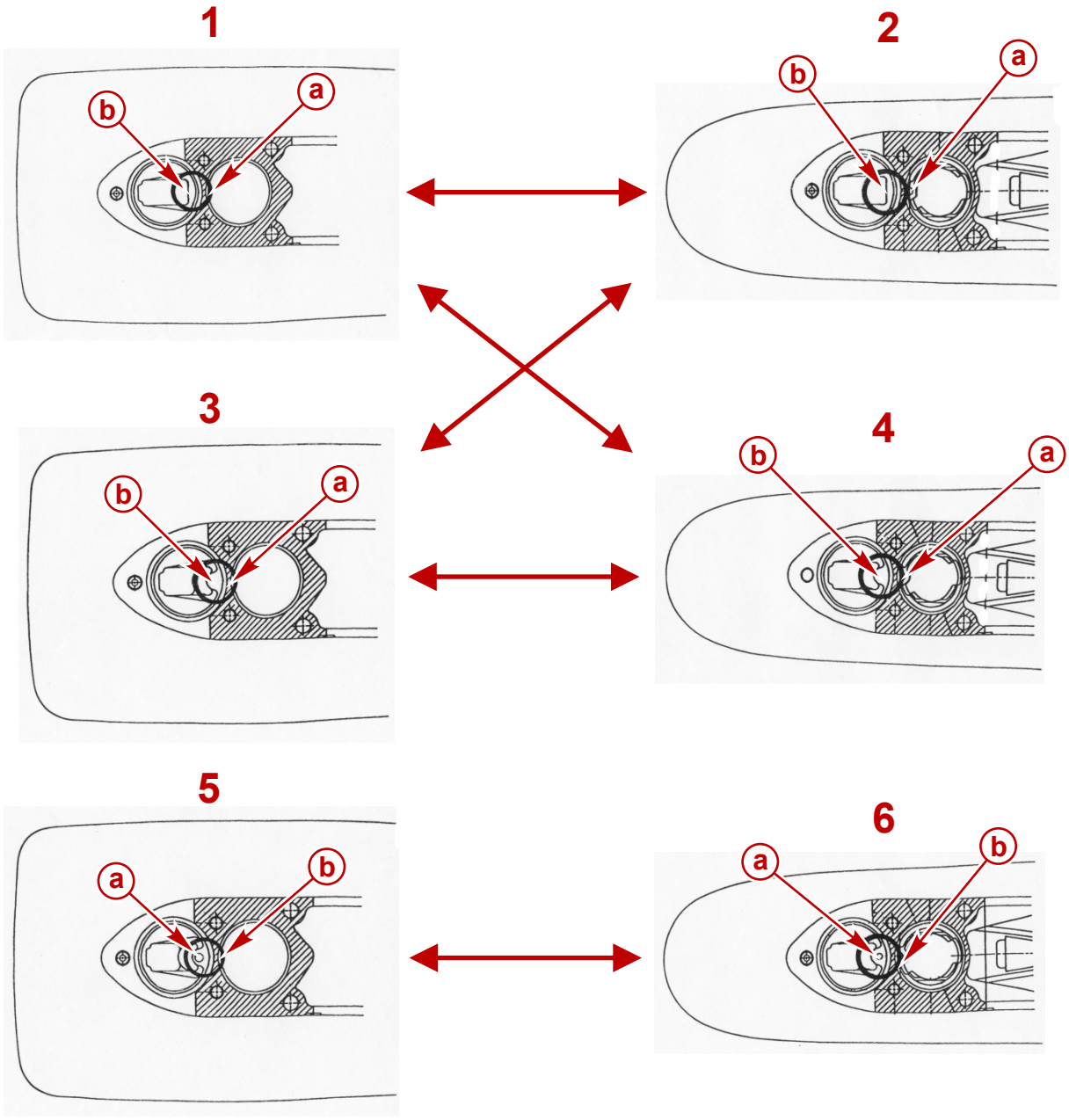
NOTE: *Gearcase and driveshaft housings with the oil circulation system will not interchange with housings from older Bravo units without oil circulation. If housings are intermixed, gear oil will drain out of the drive unit, through the interconnecting oil passage. Refer to Service Bulletin 91-20.*

Bravo Driveshaft Housing/Gear Housing Compatibility Diagrams

NOTE: *All diagrams are of the mating surfaces at the driveshaft bore and forward water cavity areas. Arrows connecting diagrams mean that units are compatible.*



a - Oil hole

b - No oil hole

1 - Bravo driveshaft housing - old style
2 - Bravo gear housing - old style
3 - Bravo driveshaft housing - intermediate style
4 - Bravo gear housing - intermediate style
5 - Bravo driveshaft housing - new style
6 - Bravo gear housing - new style

NOTE: *Remove and discard any oil passage plugs found in housing mating surface before assembling unit.*

1993

- Bravo Three introduced.

- Uses two counter-rotating propellers to reduce propeller torque, improve tracking and handling.
- Used two-piece gearcase housing.
- Extension held in place with trim tab bolt.
- Negative trim must be limited by to 2.54 cm (1 in.).
- Exhaust tube must be used instead of exhaust bellows.
- Bravo One propshaft bearing carrier changed to load ring design (C3 carrier [Service Bulletin 93-10]).

1995

- Propshaft bearing carrier anode added on Bravo One models.
- Replaceable thrust wear pads added on all driveshaft housings.

1996-1/2

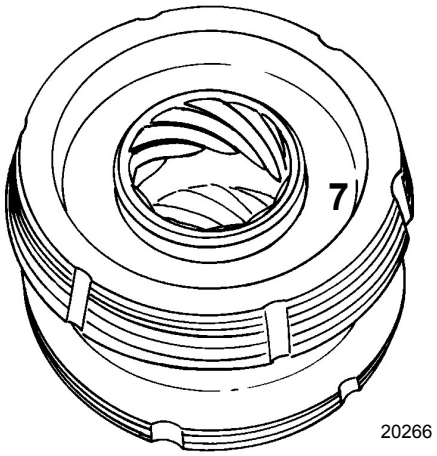
- Bravo Three changed to one-piece gearcase housing (anti-ventilation plate was extended aft to replace separate extension plate). Older housings will supercede to this housing.

1997-1/2

- New shift components (in driveshaft housing) to lower shift effort (Service Bulletin 97-18).
- All parts will retrofit in older driveshaft housings.
- New driveshaft housing with elongated aft trim anchor hole (Service Bulletin 98-16). Aft trim anchor pin spacer must be correctly positioned to limit negative trim on Bravo Three models.

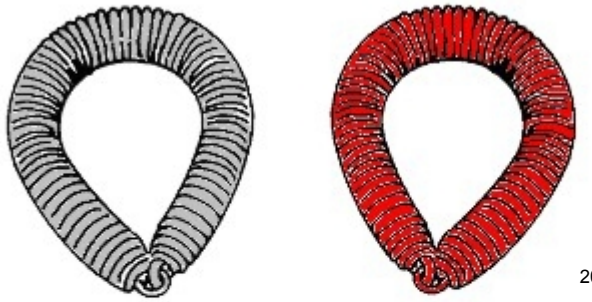
Shift Changes for Bravo One/Two/Three and BlackHawk

1. Bravo One/Two/Three/BlackHawk New Shift Parts
   a. The Cone clutch has changed. The spring ramp area is different. The yoke groove has been increased by 0.025 cm (0.010 in.) in width. The clutch is identified by a number 7 stamped down at the bottom of the spring groove on every clutch.



Cone Clutch (52-807375A2)

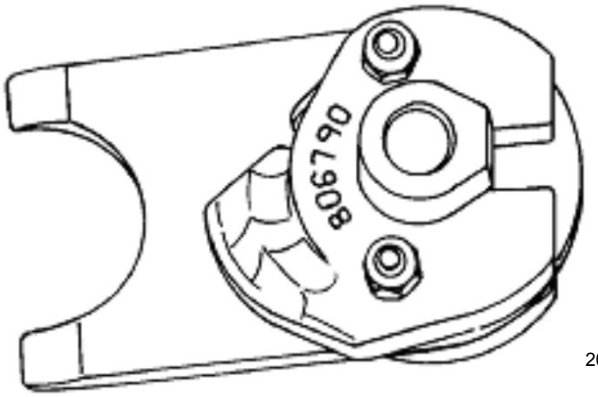
b. The garter springs now have a smaller diameter on the Bravo One/Two/Three only and are colored orange for easy identification.



20267

Silver Color-Blackhawk (24-818829)/Orange Color-Bravo One/Two/Three (24-93505)

c. The shift cams have a new ramp profile on them and will be identified with the casting part number molded into the top surface of the cam (as shown below on the assembly).



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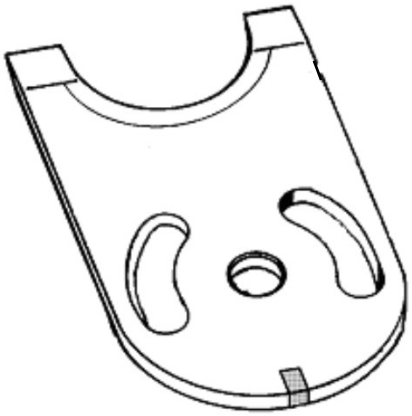
Shift Cam Assembly (806552A1)

d. The shift yoke has been made 0.01 cm (.004 in.) thicker. The yoke will be identified by a yellow paint stripe (illustrated on the drawing below).



20269

Shift Yoke (806552)

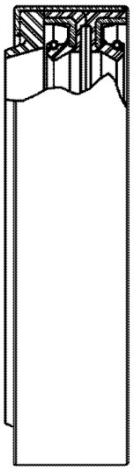
2. Following is a list of the kits that are available to back fit the new shift components into every Bravo unit from the first one built:
   a. Yoke and cam assembly, for units starting with serial number 0K091000 and above.
   b. Clutch kit assembly (52-807375A1), which includes the new cone clutch and springs as well as the yoke and cam assembly and two new socket head Allen screws for use on units starting with serial number 0F345868 through 0K090999.
   c. Shift upgrade kits, for use in units with serial number 0F345867 and prior, back to the first Bravo unit built. Each kit will be preassembled and consist of the following parts:

- (2) new driven gears
- (1) new cone clutch
- (2) new garter springs
- (1) upper drive shaft
- (2) thrust bearings
- (2) thrust bearing races
- (1) new shift yoke
- (2) shift cams
- and the miscellaneous bolts and spacers required to assemble the kits.

The Shift Upgrade kit part numbers are as follows:
32 TEETH (43-807436A1)
30 TEETH (43-807437A1)
29 TEETH (43-807438A1)

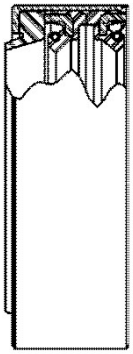
1999-1/2

- The propshaft oil seals, used in the Bravo Three and BlackHawk bearing carrier and the outer propeller shaft assembly, have been upgraded from two back-to-back seals to a new one-piece, canister type design.
- The two individual seals for the inner shaft are now housed in a canister that is inserted into the outer propeller shaft assembly.
- The two seals for the outer propshaft are also housed in a canister that is installed in the bearing carrier.



20431

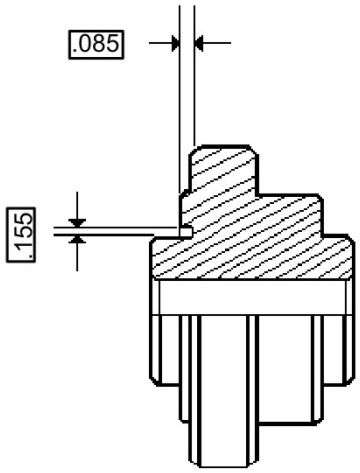
Bravo Three and BlackHawk outer prop shaft oil seal (26-861694)



20433

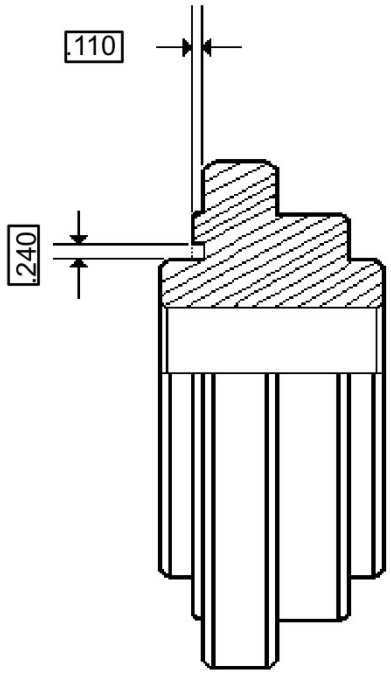
Bravo Three and BlackHawk inner prop shaft oil seal (26-861695)

The following drawings show the area and dimensions on the seal installation tools to be modified, so that they can be used to install the new one-piece canister type oil seals. Present tools can be modified in the areas shown to allow them to work with the new and old seals.



20434

Inner seal installation tool (91-805358)-modifications 0.39 x 0.22 cm (0.155 x 0.085 in.)



20435

Outer seal installation tool (91-805372)-modifications 0.61 x 0.28 cm (0.240 x 0.110 in.)

2000

There were four new Bravo 2000 drive units (S/N 0M100000 and above). These units have had many changes made to enhance durability and most of the internal parts in these drives will not backfit older Bravo product.

Use Service Manual #28 for 2000 models. Use Service Manual #11 for all older models.

Bravo 2000 Models

	Versions	Product Changes	Models Effected
Bravo (Standard)	Bravo One (all ratios), Bravo Two (all ratios), Bravo Three (all ratios)	Improved bearings and clutch, new style cut gears, aluminum lower bearing chimney	Standard on all gasoline engines 4.3L-5.0L-5.7L-6.2L-496
Bravo X	Bravo One X (all ratios), Bravo Two X (all ratios), Bravo Three X (all ratios)	Improved bearings and clutch, larger U-joint, near-net forged gears, steel lower bearing chimney	Standard on all diesel engines and 496 H.O.
Bravo XZ	Bravo One XZ (1.36 ratio), Bravo One XZ (1.50 ratio)	Improved bearings and clutch, larger U-joint, near-net forged gears, steel lower bearing chimney, Hi-Performance propshaft kit	Standard on all 500HP engines, Optional on 496 H.O.
Bravo XR	Bravo One XR (1.26, 1.35, 1.50 ratio)	Improved bearings and clutch, larger U-joint, straight tooth net forged gears, steel lower bearing chimney, Hi-Performance propshaft kit	Standard – 575HP Hi–Performance engines, Optional – 500HP Optional on 496 H.O.

Driveshaft Housing Changes

ALUMINUM BEARING CHIMNEY IN TOP COVER

All Bravo 2000 models

- The Aluminum bearing chimney in the top cover is machined to a shorter height to allow for the new narrower needle bearing race.

DRIVE SHAFT HOUSING BEARING CHIMNEY

Standard Bravo

- The aluminum bearing chimney in the driveshaft housing is machined to a shorter height to allow for the new narrower needle bearing races.

Bravo X, XZ, XR

- There will be a new steel lower bearing chimney that threads into the driveshaft housing, similar to the one that was used in the BlackHawk drive.

DRIVESHAFT HOUSING DRIVEN GEARS

Standard Bravo

- There will be new driven gears (spiral bevel) with the new thick web floor and narrower needle bearing.

Bravo X, XZ

- The Bravo X and XZ will have (spiral bevel) Near-Net Forged gears, including both driven gears with the new thick web floor and narrower needle bearing, as well as a new Near-Net Forged U-joint pinion gear with an 18 tooth internal spline for all ratios.

Bravo XR

- The Bravo XR will have straight tooth, Net-Forged gears, including both driven gears with the new thick web floor and narrower needle bearing, as well as a new Net-Forged U-joint pinion gear with an 18 tooth internal spline for all ratios.

DRIVEN GEAR NEEDLE THRUST BEARINGS

All Bravo 2000 models

- There will be new larger needle radial thrust bearings for the driven gears.

DRIVEN GEAR THRUST RACES

All Bravo 2000 models

- Because of the change to new, larger needle radial thrust bearings; there will also be a change to the driven gear radial thrust bearing race, from the old thickness of 2.3-2.4 mm (0.091-0.094 in.) to the new thickness of 1.5-1.6 mm (0.061-0.064 in.).

NEEDLE THRUST BEARINGS BETWEEN THE GARTER SPRING AND THE DRIVEN GEAR

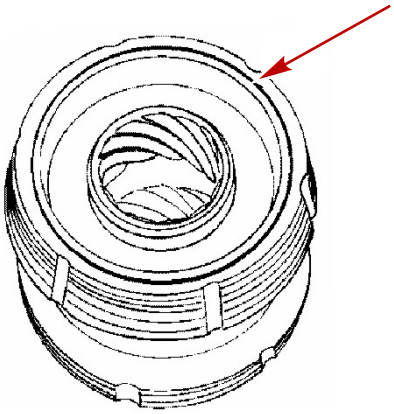
All Bravo 2000 models

- There will be a new larger needle, radial thrust bearing between the garter spring and the driven gear. The bearing and race are now combined into one assembly.

CONE CLUTCH

All Bravo 2000 models

- There will be a new cone clutch identified with a shallow groove machined on the top flat surface of the cone clutch.



20436

UNIVERSAL JOINT ASSEMBLY

Standard Bravo

- The U-joint assembly will remain the same as today (L-15, 15 tooth spline input yoke) and use the present cross and bearing assemblies.

Bravo X, XZ, XR

- There will be a new, larger (L-18) U-joint assembly that will have an 18 tooth spline input (stub) yoke and use a larger cross and bearing assembly.
- There is a new retainer nut that has the stub yoke oil seal installed into it, as well as the O-ring groove in it, for installing the O-ring that seals the outside diameter of the retainer nut. The new spanner wrench is required for removal and installation of the new retainer nut.

Spanner Wrench for L-18 U-joint Bearing Retainer	91-862219A1

- There is also a new thrust washer in the U-joint assembly, behind the oil seal in the carrier retainer nut, that is only used with the L-18 U-joint assembly.

SPLINED COUPLER BETWEEN UPPER DRIVESHAFT AND LOWER DRIVESHAFT

All Bravo 2000 models

- There is a new splined coupler between the upper driveshaft and lower driveshaft. The only difference is that the spline has had a small radius added to the bottom root of the spline. Both the old coupler and the new coupler will work on old and new product. The reason that the radius was added to the bottom root of the spline groove was to give added strength in that area of the coupler.

20438

Old Style Spline/New Style Spline

Lower Unit Changes

BRAVO ONE AND THREE LOWER DRIVESHAFT

All 2000 Bravo One and Three lower units

- There will be a new driveshaft only in the Bravo One and Three with induction hardened splines on both ends of the shaft. There will be a larger mid-section on the shaft as well. The Bravo One will use the same drive shaft assembly as the Bravo Three. A screw and washer will be used to retain the pinion gear to the shaft, in place of the pinion nut and washer used on older Bravo One product.

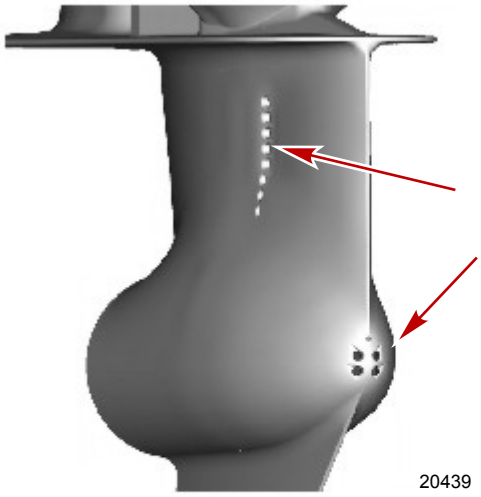
WATER PICKUPS

Bravo standard and X models

- The Bravo One will be offered with the new Dual Water pickup style gearcase. This unit draws water from the side water inlets and from four inlet holes in the front of the torpedo area. The front pickups provide a ram effect and will allow a slightly higher X dimension for the drive unit. If they become plugged from beaching the boat, they will self-clean when under way again.

Bravo XZ, XR models

- The Bravo One will be offered in both the dual water pickup and the Hi-Performance low water pickup style gear housing.



New Bravo One dual water pickup style gear housing

HI-PERFORMANCE PROPELLER SHAFT ASSEMBLY

Bravo One XZ, XR

- These drives are equipped with the new Hi-Performance propeller shaft assembly. The assembly includes a new heavy-duty bearing carrier, with a larger bearing and piloted gear and a larger diameter propshaft.

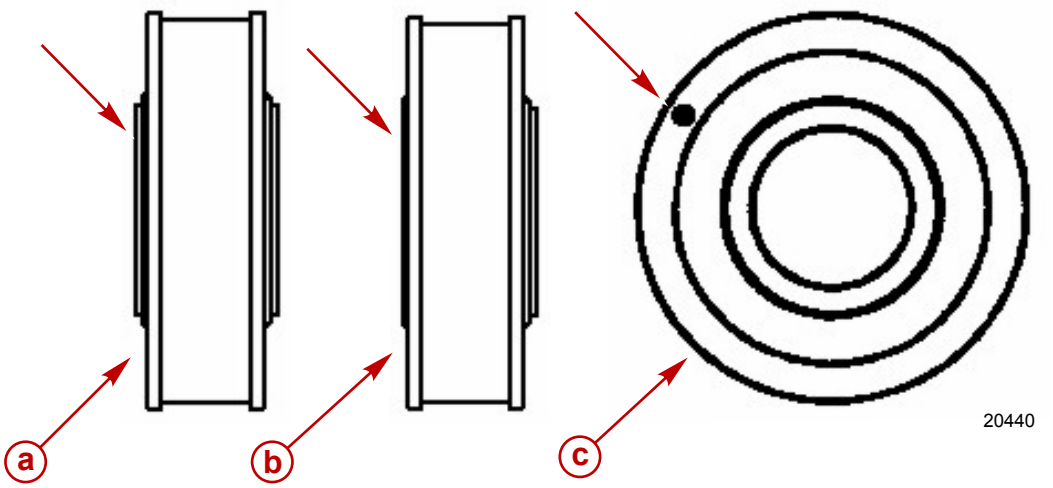
Transom Assembly Changes for Bravo 2000 Models

INTERMEDIATE SHIFT CABLE GUIDE EXTENSION

The Gimbal Housing for both Alpha One and all Bravo product now has a new intermediate shift cable guide extension cast into the housing. There is also a new plastic cable guide insert for the extension in the housing. This extension will help when installing a new intermediate shift cable. It now extends out over the flange of the exhaust pipe. It will help prevent the shift cable from being pushed into the engine coupler area.

NEW GIMBAL BEARING

There will be a new gimbal bearing installed in the gimbal housing for Bravo 2000 product only. The new bearing and cartridge will look just like the current gimbal bearing and cartridge. The only difference will be at the center race of the bearing. If you look at the new bearing (from the side), the center race will look like it is offset towards the notched side of the bearing cartridge. The center race has been machined down on one side to provide extra clearance for the L-18 U-joint assembly. The new bearing will also be identified with a **red** paint dot on the aluminum cartridge of the assembly. This new gimbal bearing will be the only gimbal bearing used in all Bravo transom assemblies.



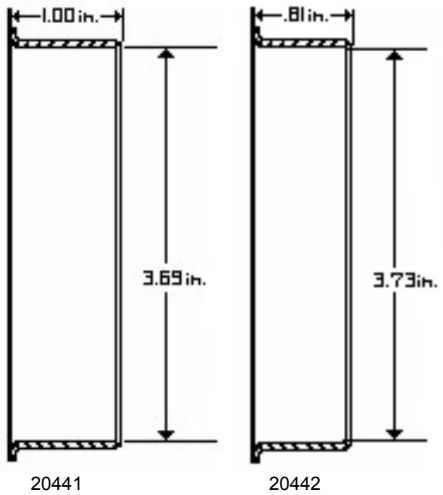
a - Current bearing (30-60794A4) - center race thickness even on both ends

b - New bearing (30-862540A3) - center race machined down on the side that arrow is pointing towards

c - New bearing (30-862540A3) - identifying **red** dot shown on side of aluminum cartridge

NEW UNIVERSAL JOINT BELLOWS ALUMINUM RETENTION SLEEVE

There will be a new U-joint bellows aluminum retention sleeve (retainer ring). The retention sleeve will have a larger inside dimension and will be narrower than the current retention sleeve. This change was required to allow clearance for the new larger (L-18) U-joint assembly. The change will be made on all Bravo transom assemblies.



Original U-joint bellows retention sleeve **New U-joint bellows retention sleeve**

TRIM CYLINDER TILT-LIMIT SPACERS

New trim cylinders, with the tilt-limit spacer installed by the factory, will be shipped on all Bravo Transoms. The spacer limits the total amount of trailer limit travel by 16 mm (5/8 in.) when the unit is raised to the trailering position. The overall total travel of the trim cylinder with the tilt-limit spacer factory installed will be 672 mm (26 7/16 in.) from anchor pin hole to anchor pin hole. Current trim cylinders, without the tilt-limit spacer, have an overall total travel of 687 mm (27 1/16 in.) from anchor pin hole to anchor pin hole, +/- 3 mm (+/- 1/8 in.). The casting numbers that you now identify the cylinders with (98704 and 98703) will be changing to new casting numbers (98719 and 98718) for the cylinders with the tilt-limit spacer installed.

All diesel transoms and service parts Magnum and Hi-Performance transoms will be built with the tilt-limit spacer installed in the cylinders.

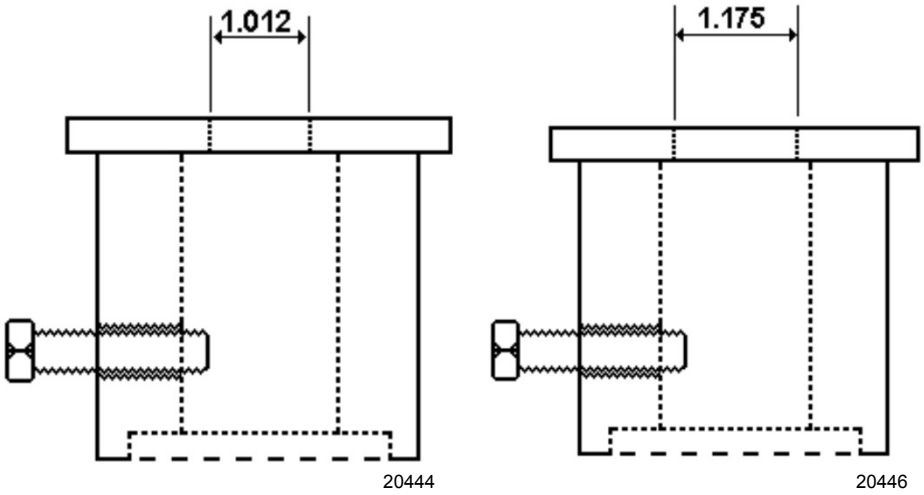
Additional Information

INSTALLING A BRAVO X MODEL ON AN OLDER TRANSOM ASSEMBLY

See MerCruiser Service Bulletin 2000-8 for information on installing a Bravo X model on an older transom assembly.

BRAVO THREE DRIVESHAFT HOLDING TOOL MODIFICATIONS

The new Bravo Three, lower driveshaft requires a larger opening in the driveshaft holding tool to accommodate the larger shaft used on Bravo 2000 models. You can order a new holding tool, or modify an older version. In order to use an older Bravo Three Driveshaft Retaining Tool on a Bravo Three 2000 Standard, or X drive you will need to modify the tool to the 29.7-29.8 mm (1.170-1.175 in.) dimension to make it work. This modification will change the tool so that it will not work with the older Bravo Three with the smaller diameter driveshaft. Therefore you will need to retain an original tool to work with the older Bravo Three. The following artwork will illustrate the change to the lower driveshaft retaining tool.



Old tool for Pre-2000 Bravo Three models (91-805381) **New tool for Bravo Three 2000 models (91-863738)**

NEW TOOLS FOR BRAVO 2000 MODELS

91-862219A 1 - Spanner Wrench for the U-joint retainer nut on units with L18 U-joints (X series).

17-862218 - Replacement pins for spanner wrench

91-862531 - Lower bearing chimney remover/installer for units with the steel bearing chimney (X series).

91-862530 - Bearing installer for the new shorter bearing sleeve and needle bearing on all Bravo 2000 models. Used with components of the 91-90244A1 Puller/Driver Assembly.

91-862546 - U-joint bellows retention sleeve removal tool. Required to remove the new larger inside diameter sleeve without damaging it.

91-840383A 1 - If working on the gearcase housing that has the Hi-Performance propshaft kit installed (factory installed on XZ and XR models), you will need kit 91-840383A1, which includes one of each of the following:

91-840393 - Spanner wrench

91-840385 - Seal installer

91-840388 - Seal protector

91-862064A 1 - A new tool has been released to remove the propshaft seal and bearing from the carrier on all Bravo Three models. Bearing/seal remover will press out the caged needle bearing and the propshaft seal in one step, preventing damage to the carrier.

91-863738 - Bravo Three driveshaft retaining tool. Required to accommodate new larger diameter lower driveshaft.

BRAVO ONE XR DRIVES GEAR RATIO CHANGE

New lower gear sets are now available to convert 1.50:1 Bravo One XR drives to either a 1.26:1, or 1.35:1 overall gear ratio for boats that require a gear ratio change, to improve performance. The gear sets are available from the parts department.

Gear Set	Part Number
1.26	43-840870A 1
1.35	43-840872A1

Complete Bravo One XR drive units are also now available in both low water pickup and dual water pickup gearcase versions in 1.26: and 1.35:1 gear ratios.

BRAVO 2000 STYLE SERVICE REPLACEMENT GEAR SETS FOR ALL BRAVO DRIVE UNITS

The Bravo driveshaft housing gears and kits available from Mercury Precision Parts/Quicksilver are being replaced by the current production gear sets used in the Bravo 2000 series drive units. They will be supplied in complete installation kits that include the pinion gear, both driven gears, the cone clutch and other required parts. Some of the kits also include the Shift Upgrade Kit, depending on the drive unit serial number. All of the parts from the kits must be used to properly complete the installation of the new gear kit. New thinner thrust bearing shim races must also be ordered.

These new gears have a thicker floor for improved strength. This is where the collet on the upper driveshaft contacts the gear. They are also double shot peened for greater durability.

The bearings in the kits have increased load capacity. The thrust bearings are larger and the garter spring bearings are now incorporated into a single assembly (previous bearing was two pieces).

The following charts will show the supersession from the old gears and kits to the new gear sets and gear kits. Also listed is a cross-reference chart of the large thrust-bearing shim race that will be required to install the new gear sets and gear kits.

NEW GEAR SETS AND GEAR KITS

Gear Set	43-883473A3	**replaces**	43-807436A6 / 43-807436A7 and 43-856184A1
Gear Set	43-883476A3	**replaces**	43-807438A5 / 43-807438A6 and 43-856186A1
Gear Set	43-883479A3	**replaces**	43-807437A5 / 43-807437A6 and 43-856188A1

Shift Upgrade Gear Kit	43-883473A4	**replaces Shift Upgrade Kit**	43-807436A1
Shift Upgrade Gear Kit	43-883476A4	**replaces Shift Upgrade Kit**	43-807438A1
Shift Upgrade Gear Kit	43-883479A4	**replaces Shift Upgrade Kit**	43-807437A1

REQUIRED NEW THRUST BEARING SHIM RACES

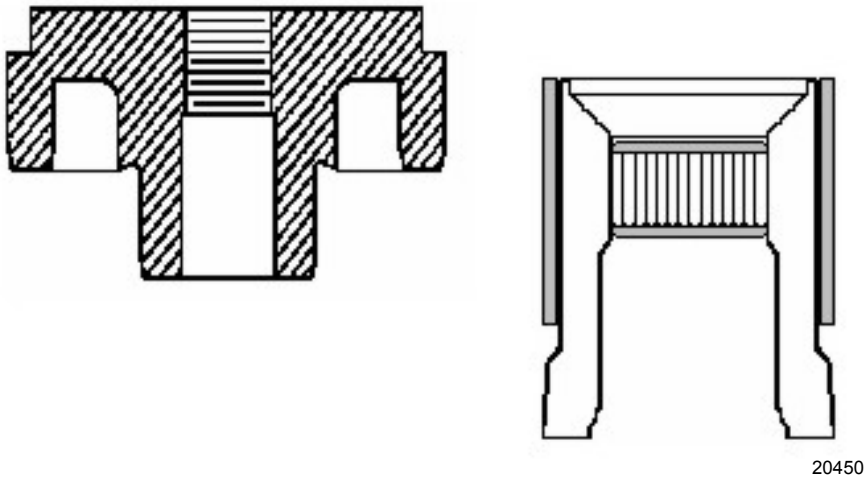
NOTE: *The number stamped on the housing will now correspond to thinner shims. Refer to the table below for specific information.*

Thrust Bearing Shim Race used with Old Gear Set		Thrust Bearing Shim Race Required with new Replacement Gear Set	
Part Number	**Shim Race Size**	**Part Number**	**Shim Race Size**
23-87560091	2.31 mm (0.091 in.)	23-861782051	1.30 mm (0.051 in.)
23-87560094	2.39 mm (0.094 in.)	23-861782054	1.37 mm (0.054 in.)
23-87560097	2.46 mm (0.097 in.)	23-861782057	1.45 mm (0.057 in.)

SLEEVE BEARING RACE DRIVERS

The following illustrations will show the proper installation tools and positioning of the sleeve-bearing races on the bearing chimney, in the driveshaft housing and top cover, for all Bravo product.

BEARING DRIVER AND CHIMNEY FOR 1999 AND PRIOR UNITS WITH OLDER BEARINGS AND GEARS

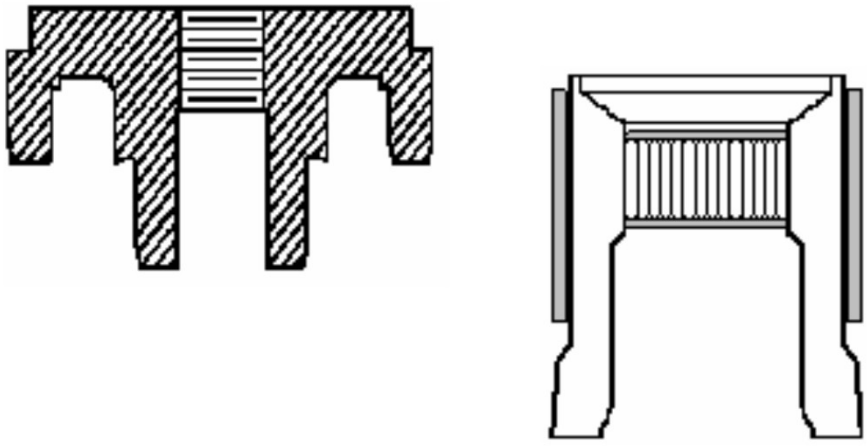


20450

Bearing Driver (91-90773T)

BEARING DRIVER AND CHIMNEY FOR THE NEW DESIGNED BRAVO GEARS AND BEARINGS WHEN USED IN 1999 AND PRIOR UNITS

A new bearing driver is required to install and properly place the sleeve bearing race in all 1999 and prior Bravo drive units when installing any of these new gear sets, or shift upgrade gear kits. The tool has a step that places the sleeve bearing race down further on the bearing chimney, in the driveshaft housing and top cover, at the correct location for this new gear set. This is to allow clearance between the gear and bearing. Sleeve placement is critical for proper operation.

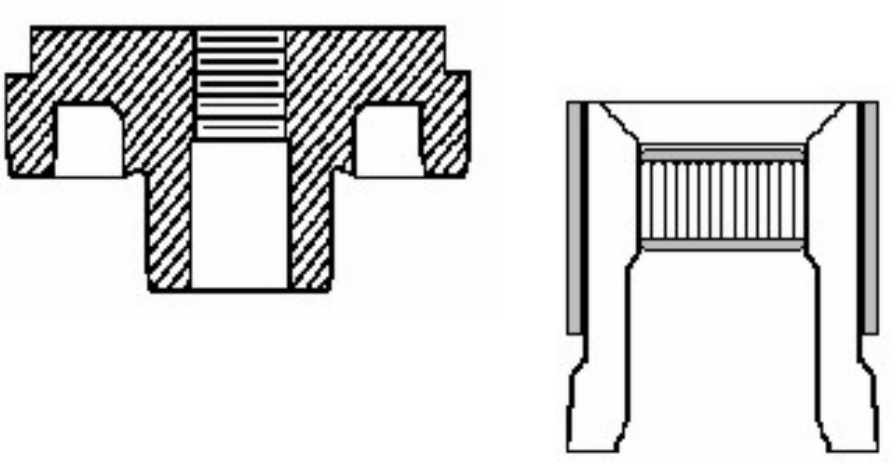


20447

Bearing Driver (91-864220)

BEARING DRIVER AND CHIMNEY FOR BRAVO 2000 AND NEWER MODELS

A different bearing driver (different from the one used for replacement gear sets used on 1999 and prior units, and the tool used on the original bravo units) is used for installing the sleeve bearing used on all Bravo 2000 series, and later drive units.



20449

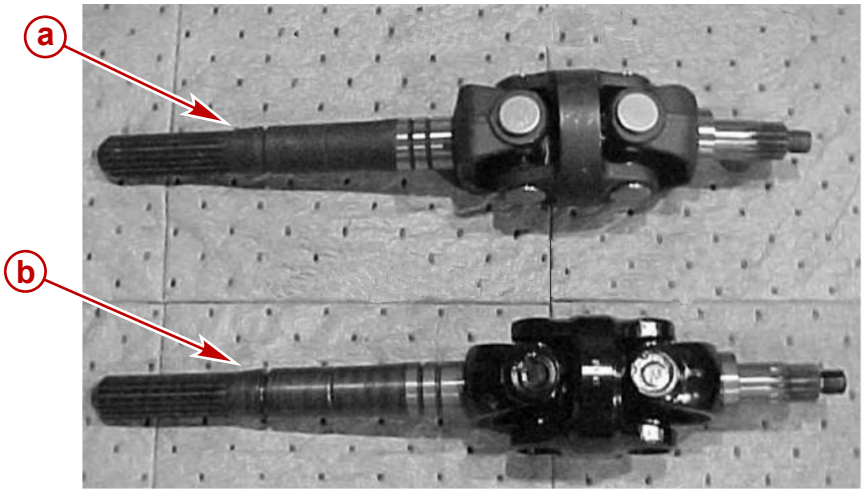
Bearing Driver (91-862530)

NOTE: *Information on the new gear sets, new thrust bearing shim races and sleeve bearing drivers can be found in MerCruiser Service Bulletin 2001-17.*

2004

U-joint Assembly (Standard and X models)

Rockwell version is No Longer Available (NLA). GKN now makes this assembly for MerCruiser.



20793

a - Rockwell U-joint assembly **b -** GKN U-joint assembly

- The Rockwell assembly is **gray** in color, where as the GKN assembly is **black** in color.
- The Rockwell assembly has the cross and bearing end caps retained with clips at the bottom of the cap, inside of the yoke ear.
- The GKN assembly has the cross and bearing end caps retained with the clips above the cap on the outside of the yoke ear, for standard Bravo and Alpha.
- The Rockwell U-joint assembly was a greaseable assembly. The GKN is a permalube style, like the Alpha U-joint assembly and cannot be greased.

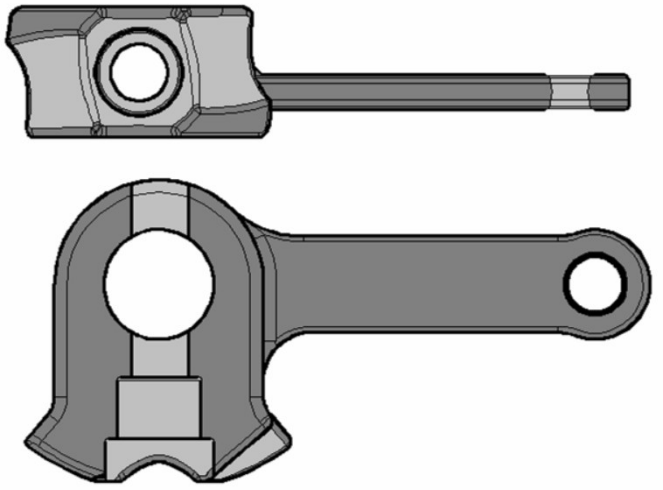
- The GKN Bravo X assembly is **black** in color and has the cross and bearing end caps retained with clips at the bottom of the cap, inside of the yoke ear, as did the Rockwell style (Bachman U-joint assembly).

Bravo Shift Effort/Noise Reduction

REVISED SHIFT LEVER DETENT

All standard Bravo drives (not on X models) received a revised shift lever detent design to reduce shift effort - in rear cover area.

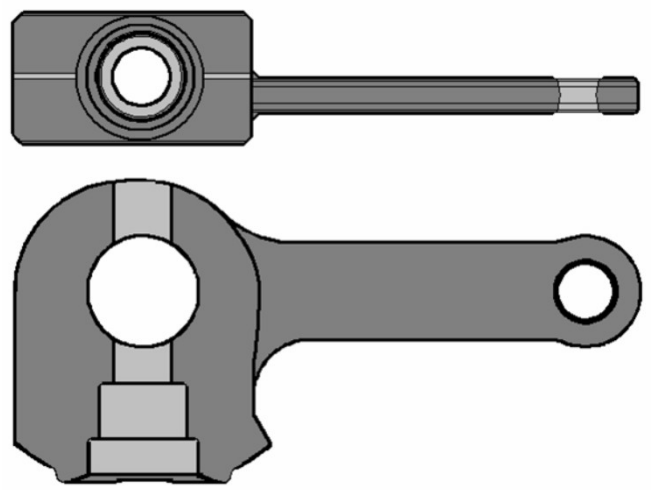
- Shape change.
- Smooth detent transition when shifting for reduced effort.



20795

Standard Bravo Shift Lever (861175A03)

Used in all standard Bravo sterndrives with low-bump brass sleeves.



20796

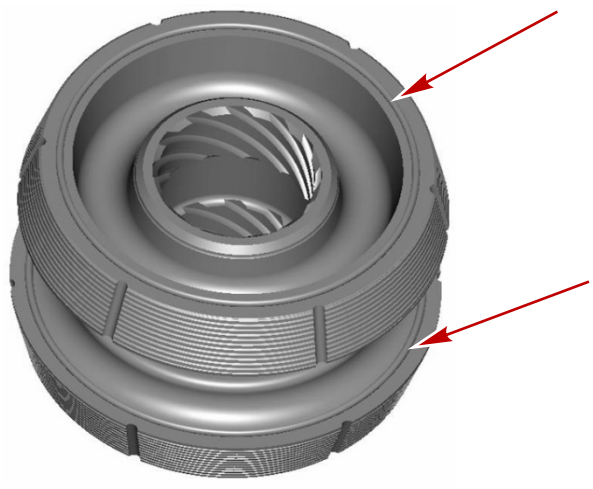
X and XR Bravo Shift Lever (861175A2)

Used in all X and XR Bravo sterndrives with high-bump brass sleeves.

CONE CLUTCH CHANGE

Bravo cone clutch has had a change of manufacturers. They are now produced with tighter tolerances.

NOTE: *New part is identified by a narrow groove cut on top (shown) and bottom (not shown) of the clutch and a third groove cut near the center of the clutch, as shown. This third groove goes* ***down*** *on assembly, as shown.*



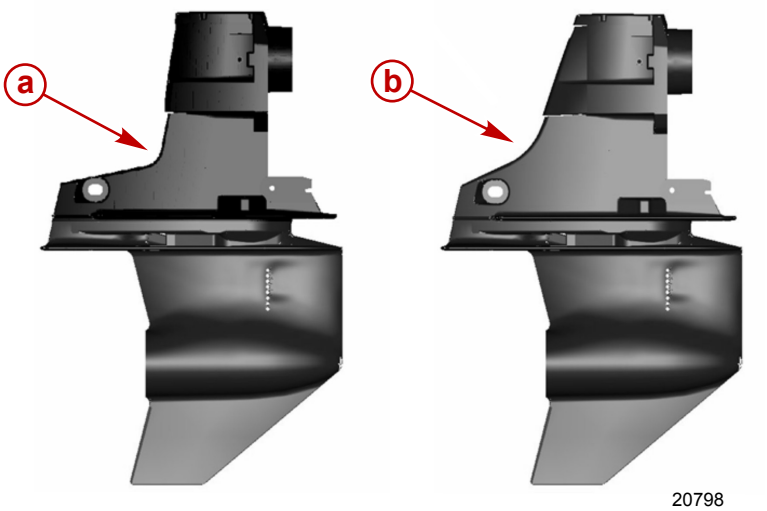
20797

SHIFT SWITCH ADDED

Shift switch installed on 496 models (at the shift plate). Switch signals engine controller of a shift occurring. This activates a revised engine management during shift event - ECM/PCM calibration change. These changes reduce the load on the clutch for a smoother shift (EFI models only).

Bravo Styling Change

Restyle was done to the driveshaft housing, top cover, rear cover and decals.



20798

a - Original design

b - New restyled design

Increased Bravo X durability

Ribbed upper driveshaft housing top cover with steel chimney.

- Increased strength and stability.
- Improved cooling for longer gear and bearing life.

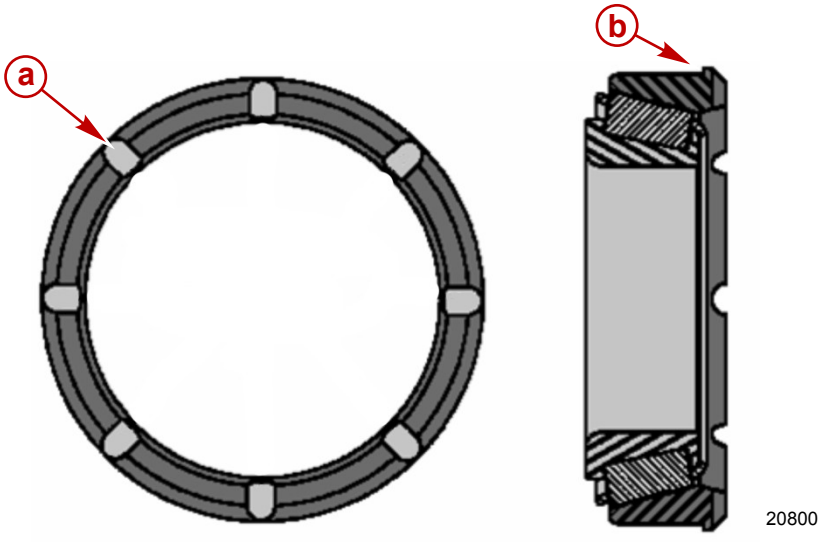
Increased Bravo XR durability

Upper driveshaft has an improved finishing process for increased durability.

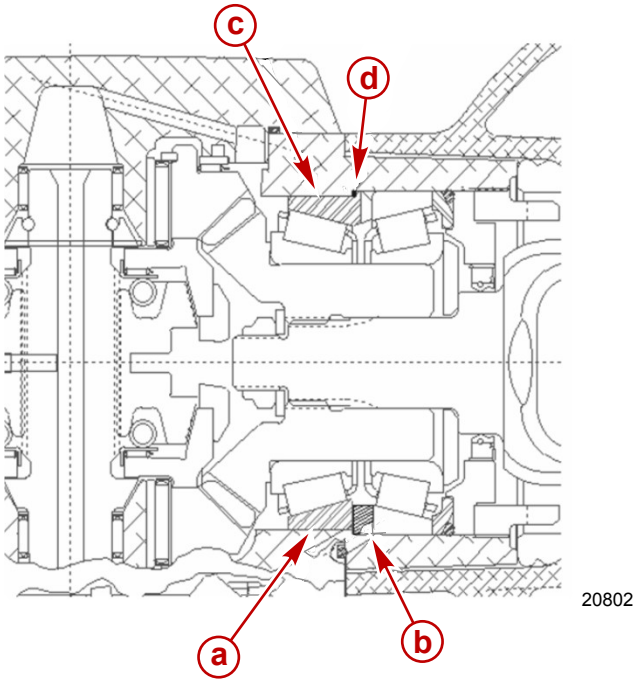
Caged needle bearing now used in driveshaft housing top cover chimney and at bottom chimney.

All Bravo Models will now have Shimmable Driveshaft Housing Gears for Increased Durability

Driveshaft housing U-joint pinion (drive) gear bearing cup has been changed to a new flanged style, which uses shims for setting clearances. Separate bearing spacer ring no longer used. Selection of shims available.



a - Eight semi-circular oil slots equally spaced on face of new bearing cup
b - Flanged edge on bearing cup



a - Original bearing cup
b - Bearing spacer ring
c - New flanged bearing cup
d - Shim location

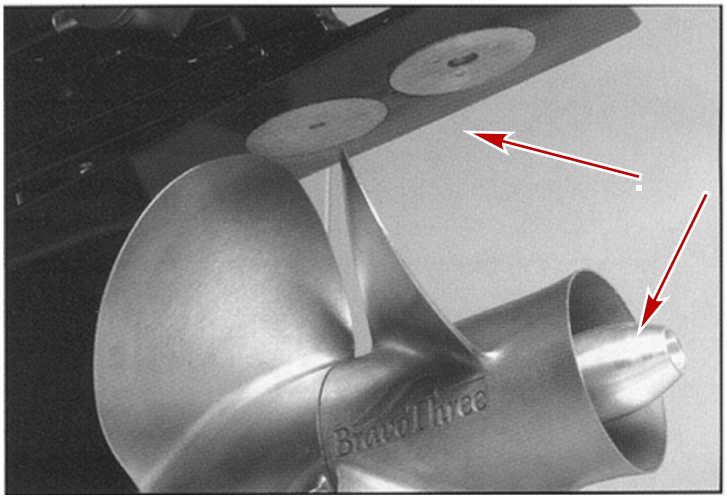
Driven gear thrust bearing races now available in different sizes for setting clearances.

New special tools and a shimming procedure used for setting driveshaft housing clearances (to be covered later in the course).

Bravo Three Changes

ADDITIONAL CORROSION PROTECTION

A second anode has been added to the underside of the anti-ventilation plate and a propshaft anode was also added.



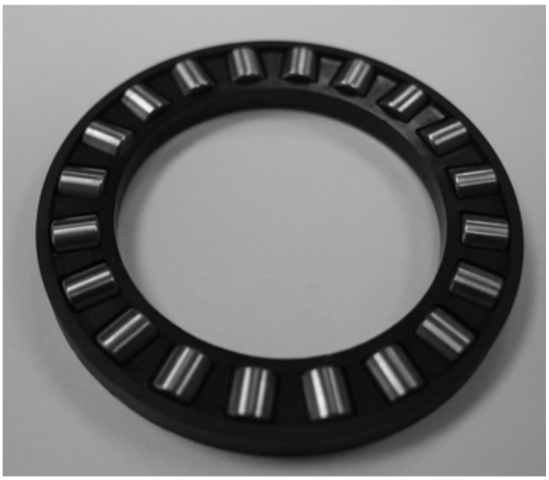
20803

IMPROVED DURABILITY

New outer propshaft thrust bearing design - changed for increased load-carrying capacity/ durability (increased roller diameters).

20805

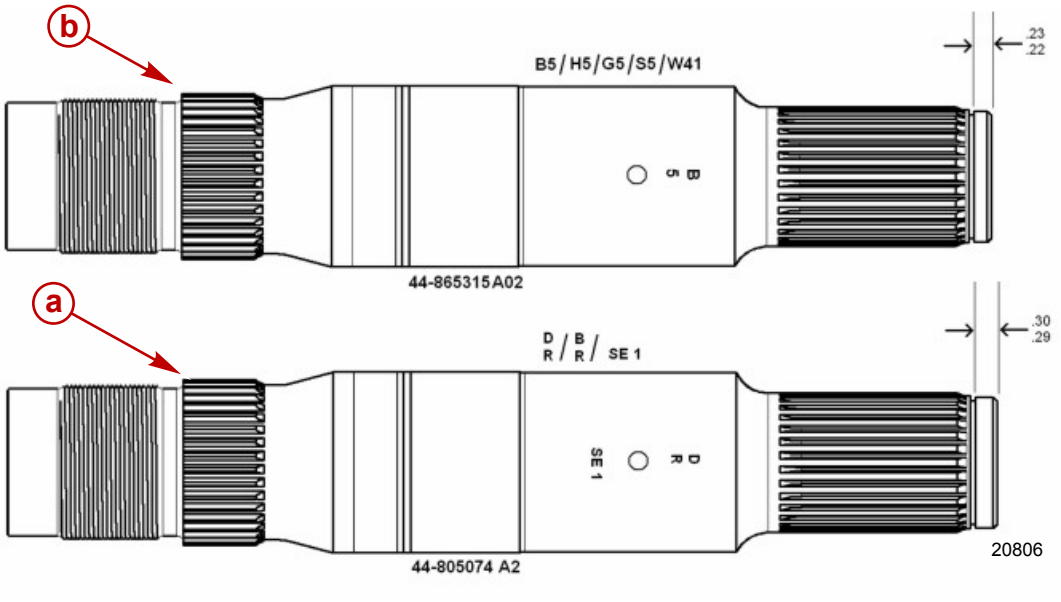
Original thrust bearing



20816

New thrust bearing

New outer propshaft (shorter - to allow clearance for new larger thrust bearing).



a - Older outer propshaft

b - Newer outer propshaft

NEW IMPROVED PROPSHAFT SEALS

New lip design, material and spring tension. Greatly reduces potential for leakage.

Allows easier end play movement checking.

2005

Oil Leak When Using the Current Magnetic Drain Plug in the XR or XZ Heavy-Duty (Blue Billet) Bearing Carrier

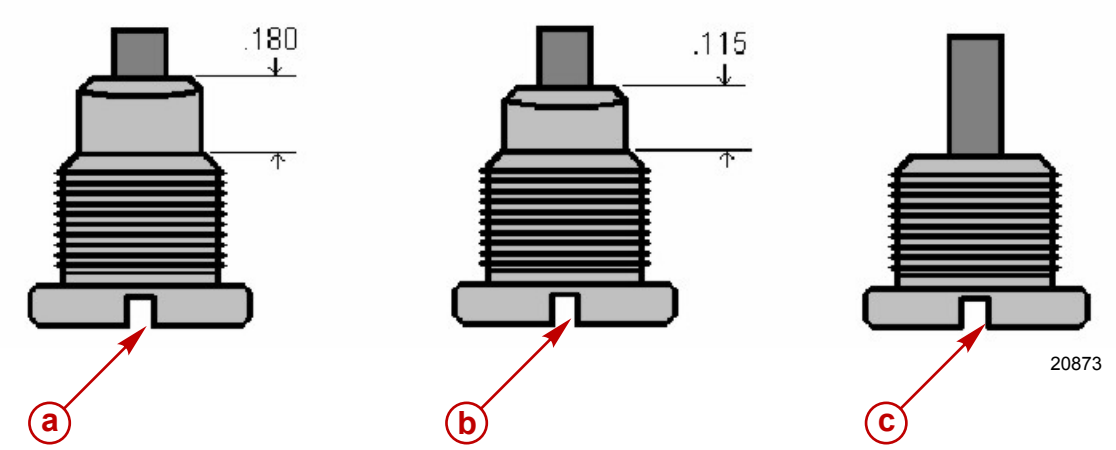
The current 22-67892 A05 magnetic drain plug, when installed in the XR or XZ Heavy-Duty (Blue Billet) bearing carrier only, is making contact at the starter pilot on the end of the plug when it bottoms in the fill/drain hole of the carrier. This prevents the gasket from seating and sealing - allowing the oil in the drive to leak out at that area.

To correct the problem use the old style fill/drain plug (P/N 22-67892 A1). All current production XR/XZ drive units have been corrected using the old style fill/drain plug (22-67892 A1). This plug will be used for a short term, until a revised plug is available.

There will be a new shorter version of the 22-67892 A05 fill/drain plug, which will have a new part number (22-67892 A06).

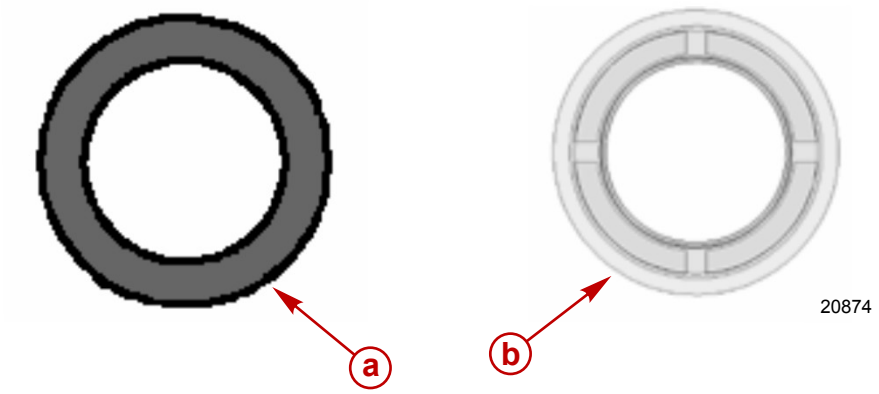
The current 22-67892 A05 plug works with all other drive product with no interference (Alpha, Bravo Standard, Bravo X). They will be used on these models until the stock is used up. Then they will be switched to the new shorter drain plug.

Following are drawings illustrating the types of plugs, including the shortened pilot dimension [1.65 mm (0.065 in.) less] version that will be going into production. Overall dimension of the new plug is the same as the A05 version.



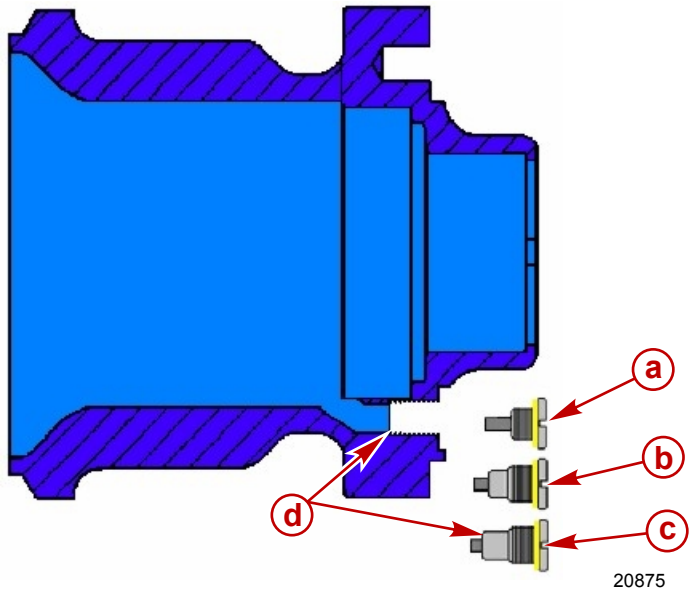
a - Plug version that contacts carrier (22-67892A05)
b - New plug (22-67892A06)
c - Original plug (22-67892A1)

A new, yellow colored, seal will be used with the new fill/drain plug.



a - Older, **blue** colored, fill/drain plug gasket (12-19183--1)
b - New, **yellow** colored, plug seal (26-830749)

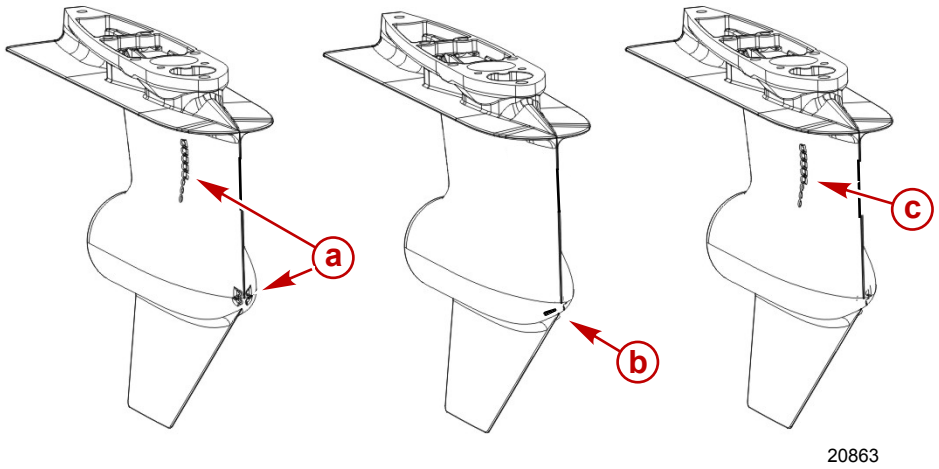
Bravo XR / XZ Blue Billet Aluminum Bearing Carrier



a - Original plug (22-67892A1)
b - New plug (22-67892A06)
c - Plug version that contacts carrier (22-67892A05)
d - Area of interference

Water Pickups and Flushing Devices Used on Bravo Drives

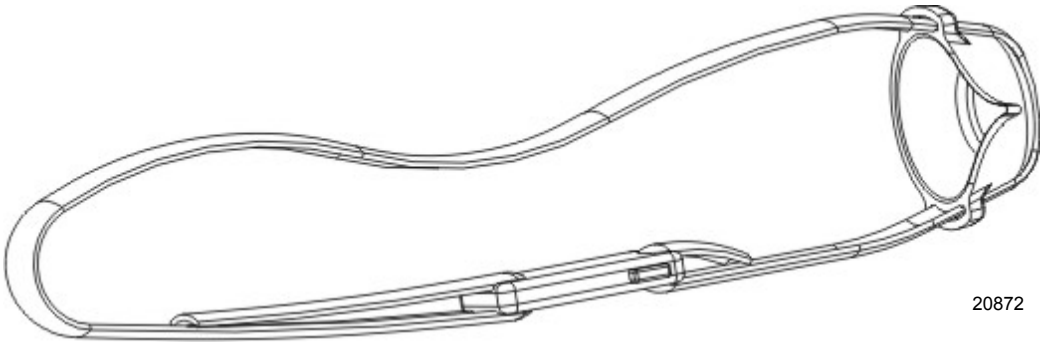
There are 3 types of water pickups available on Mercury MerCruiser sterndrives: dual-water, low-water and side pickups.



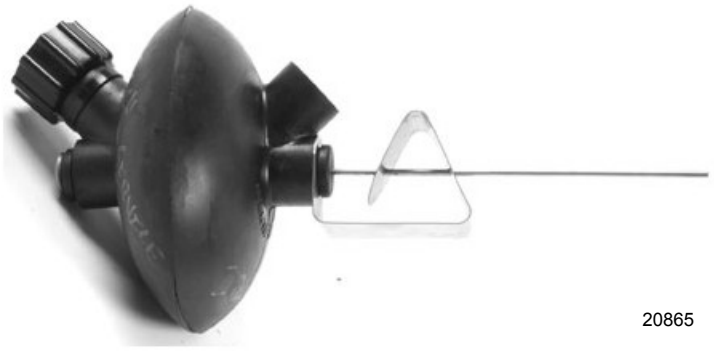
a - Dual-water pickup
b - Low-water pickup
c - Side pickup

IMPORTANT: Bravo models equipped with closed cooling require dual-water pickups and must be equipped with a thru-hull or thru-transom pickup, in addition to the sterndrive water inlets.

Flushing Devices	Part Number
Dual-water pickup	44357Q 2 (flushing device)
	881150Q 1 (gearcase flush seal kit)
Side pickup	44357Q 2
Low-water pickup	84996T1



Dual-water Pick-up Gearcase Flush Seal Kit (91-881150Q1)



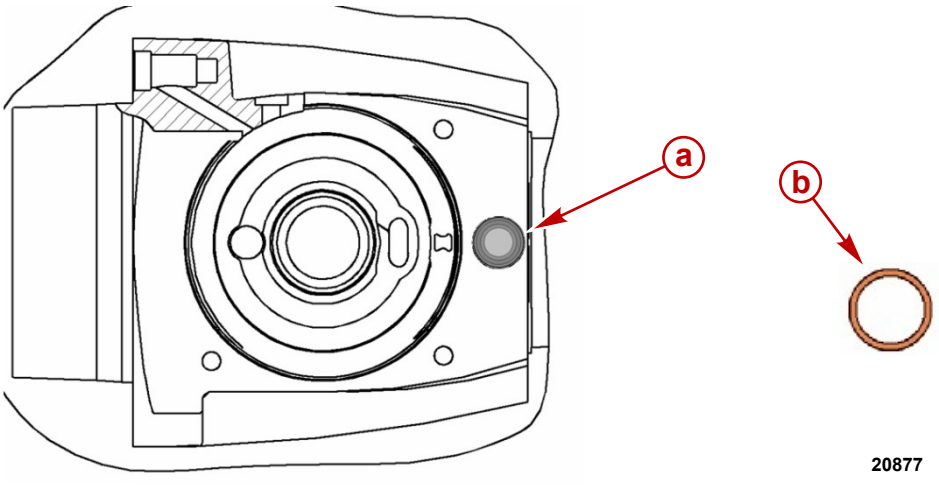
Side Pickup Flushing Device (91-44357Q2)

NOTE: *Seal Kit used to block off the front water inlet holes on the dual-water inlet gear housings.*

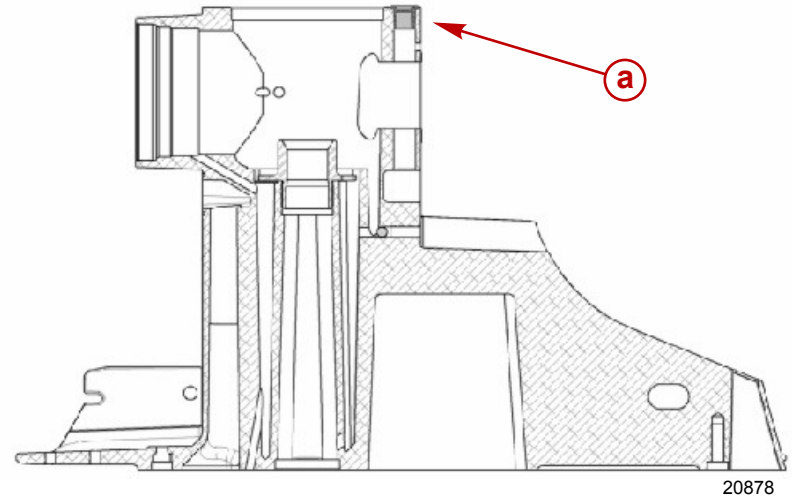
Low-water Pickup Flushing Kit (91-84996T1)

Bravo Driveshaft Housing Shift Shaft Bore O-ring Replaced with a New Seal

Shift Cavity Seal/Plug. Started with S/N 0W258350.



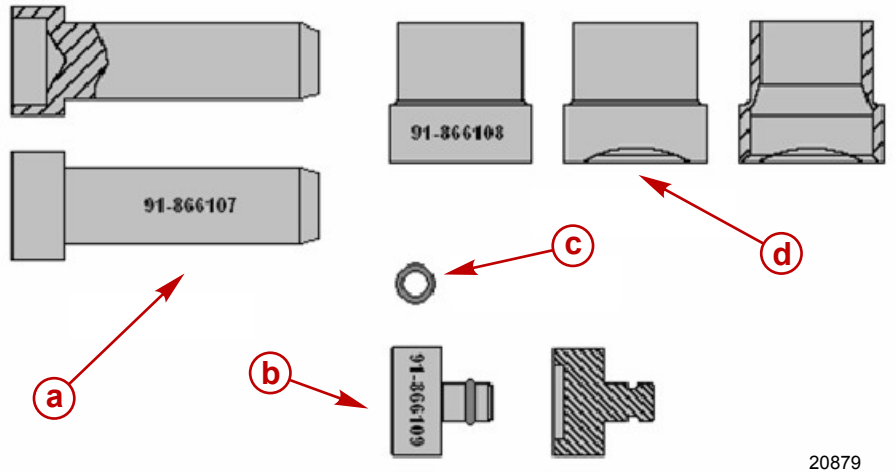
a - New shift cavity seal/plug (19-865866)
b - Original O-ring used to seal passage (25-62705)



a - New shift cavity seal/plug (19-865866)

Bravo (and Alpha) GKN U-joint Tools

Following illustrates the Bravo and Alpha GKN U-joint tool set. Individual tools are shown in full and cut away view.



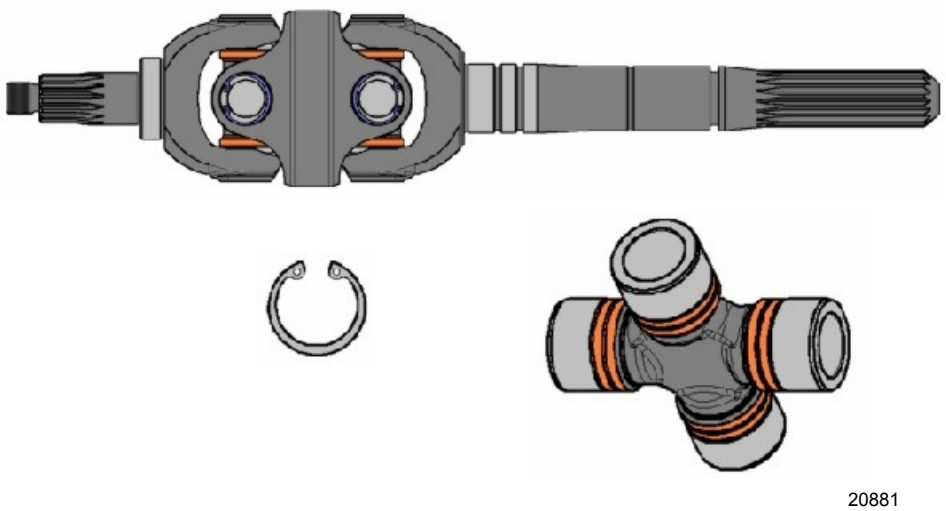
Bravo (and Alpha) GKN U-joint Tool Set (91-866107A01)

a - 91-866107
b - 91-866109
c - 25-20385
d - 91-866108

Bravo Standard GKN U-joint and Cross Bearing Kit

Cross bearing clips included in each kit will be in the sizes listed:

Qty.	Clip size	Color Code
1	1.40 mm (0.055 in.)	Light Blue
3	1.45 mm (0.057 in.)	Pink
4	1.50 mm (0.059 in.)	Green
2	1.55 mm (0.061 in.)	Red
1	1.60 mm (0.063 in.)	White

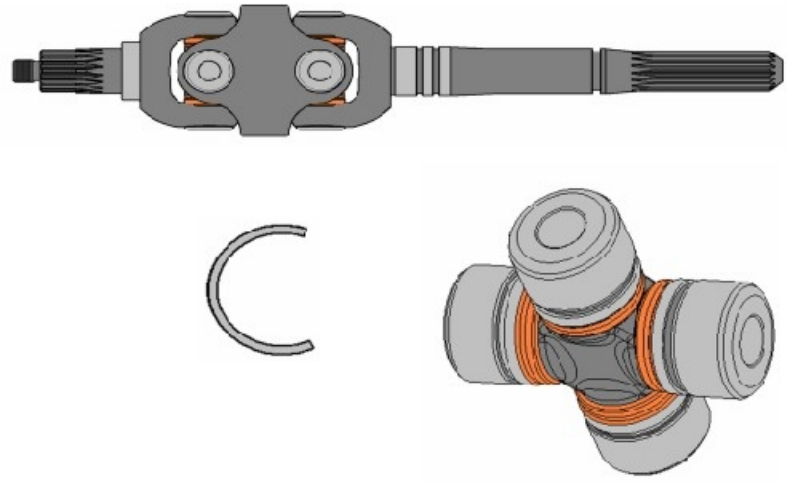


Bravo standard GKN U-joint repair parts	Part number
Universal joint assembly	864244A 2
Stub yoke gear end	864245T
Center socket	865503T
Splined yoke engine coupler end	864244A01
Cross and bearing assembly	865496A01

Bravo X Series GKN U-joint and Cross Bearing Kit

Cross bearing clips included in each kit will be in the sizes listed:

Qty.	Clip size	Color Code
3	1.90 mm (0.075 in.)	Green
4	1.95 mm (0.077 in.)	Plain
2	2.00 mm (0.079 in.)	Yellow



20882

Bravo X GKN repair parts	Part number
Universal joint assembly	865425A03
Stub yoke gear end	866134 (not sold separately)
Center socket	866137 (not sold separately)
Splined yoke engine coupler end	866133 (not sold separately)
ITS splined yoke engine coupler	866135 (not sold separately)
Cross and bearing assembly	866136 (not sold separately)

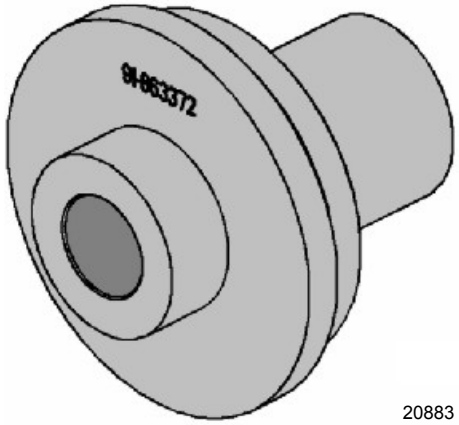
Bravo Bell Housing to Gimbal Housing Alignment Tool

If there is a vibration problem when running an engine, an engine alignment procedure should be performed. If a vibration issue still exists after the alignment, then following steps need to be done.

1. Install the Engine Alignment Shaft Tool through the gimbal bearing and into the engine coupler (similar to performing an engine alignment).

Alignment Tool Assembly	91-805475A 1

2. Slide the Bell Housing to Gimbal Housing Alignment Tool over the end of the alignment shaft (smaller tool step towards bell housing) and up to the housing. The smaller step should be inside of the bell housing case.



20883

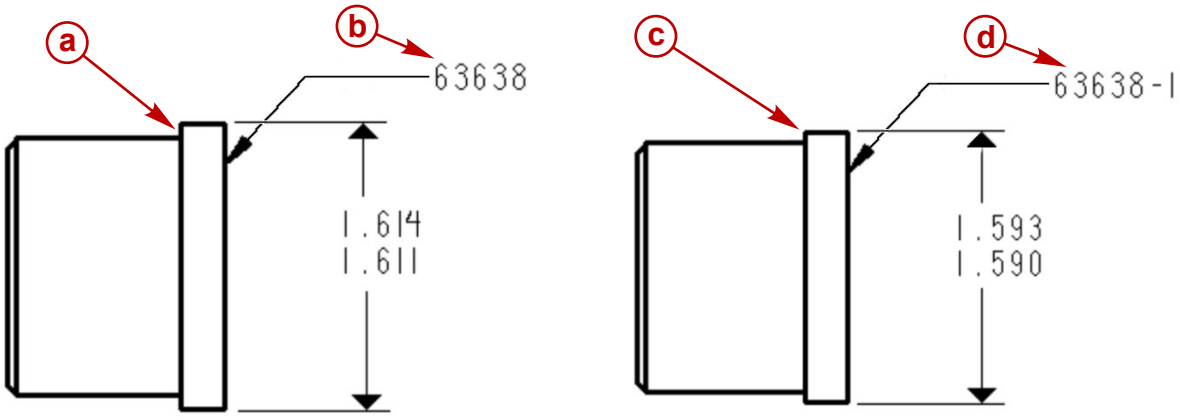
Bell Housing Alignment Tool (91-863372)

3. Check the gap between the alignment tool larger step and the bell housing case at 90 degress and at 270 degrees. The gaps should be even.
4. If they are not, then the front engine mounts should be checked for being properly attached (angled lag screws, etc.). They can be loosened up to see if the engine re-aligns itself side-to-side.
5. If a difference in the 90 degree and 270 degree gaps still exists, there may be a transom thickness issue that should be checked.

Bravo One/Two/Three Gearcase Needle Bearing Removal Tool

The old Bravo gearcase needle bearing (located above the pinion gear, on the driveshaft) removal tool too large in diameter at the top end for the newer gearcase bore.

There is a new tool available. Following will indicate the proper dimensions for the old and new tool. Dealers can order a new tool, or the old tool can be machined down.



20884

a - Older Tool (91-63638T), 40.92-41.0 mm (1.611-1.614 in.)
b - Tool identification mark (63638)
c - Newer Tool (91-63638- -1), 40.39-40.46 mm (1.590-1.593 in.)
d - Tool identification mark (63638- -1)

Manual Outline

Section 8 - Bravo Drive Unit Service

- **A - Bravo Drive Unit Components**
- **B - Bravo Driveshaft Housing Set Up - Earlier Models (Serial Number 0M198372 and Below)**
- **C - Bravo Driveshaft Housing Set Up - Later Models (Serial Number 0M198373 and Above)**
- **D - Bravo One Gear Housing Setup**
- **E - Bravo Three Gear Housing Setup**
- **F - Bravo Shift Cable Installation, Drive Unit Installation and Shift Setup**

Bravo Drive Unit Service

Section 8A - Bravo Drive Unit Components

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Exploded Views.....2
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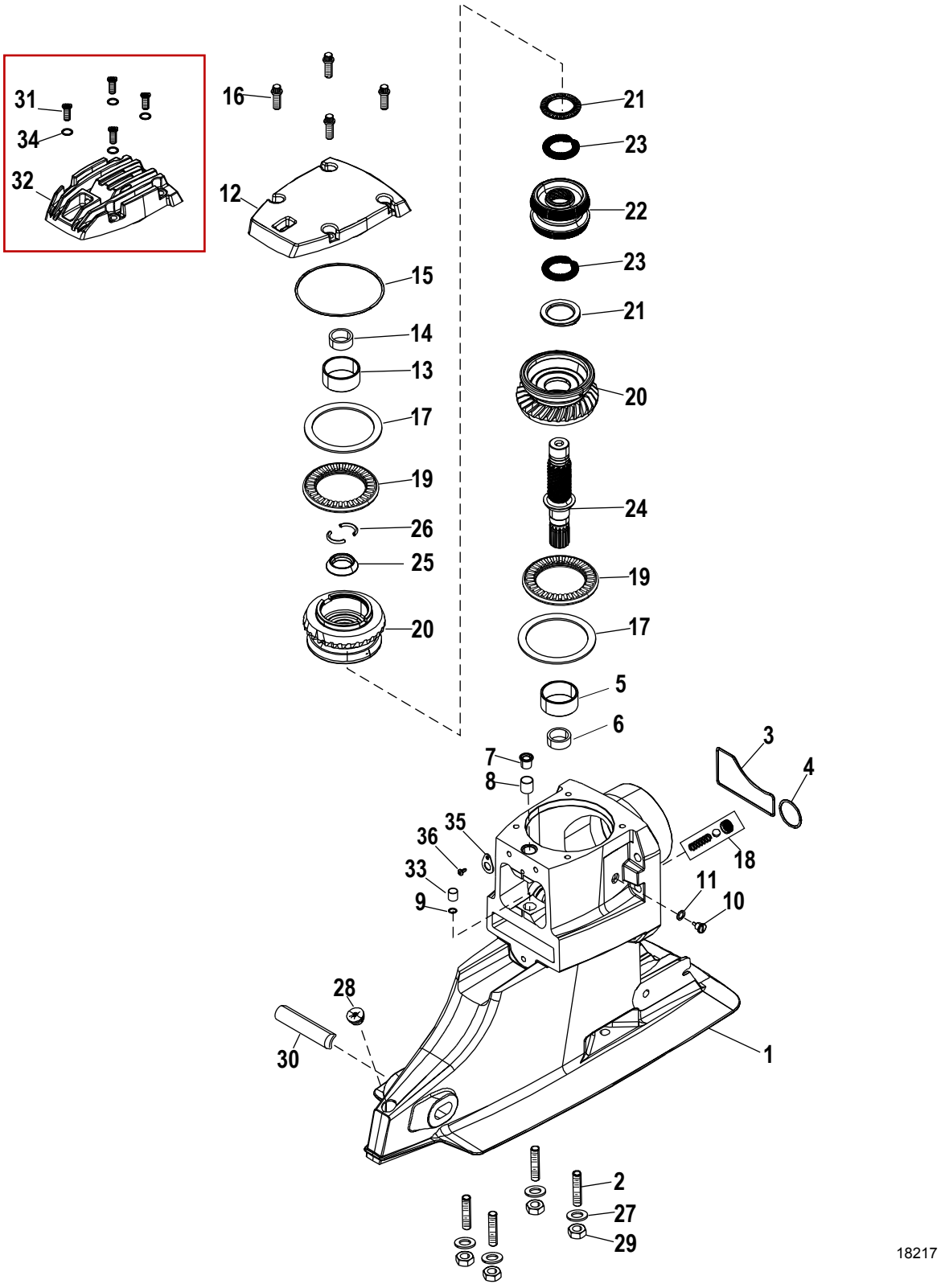
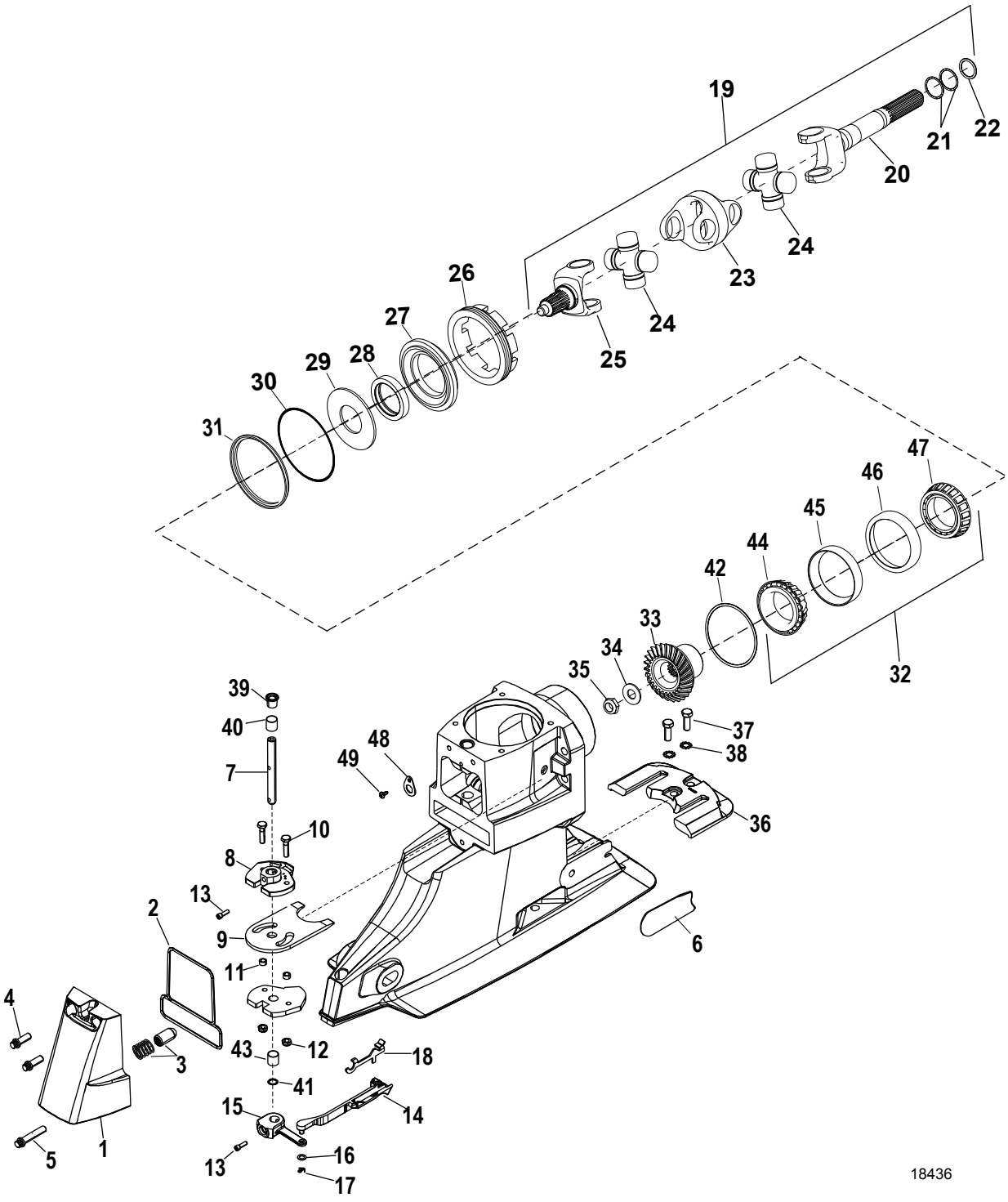
Exploded Views

Driveshaft Housing and Gears for Standard and X Series Models



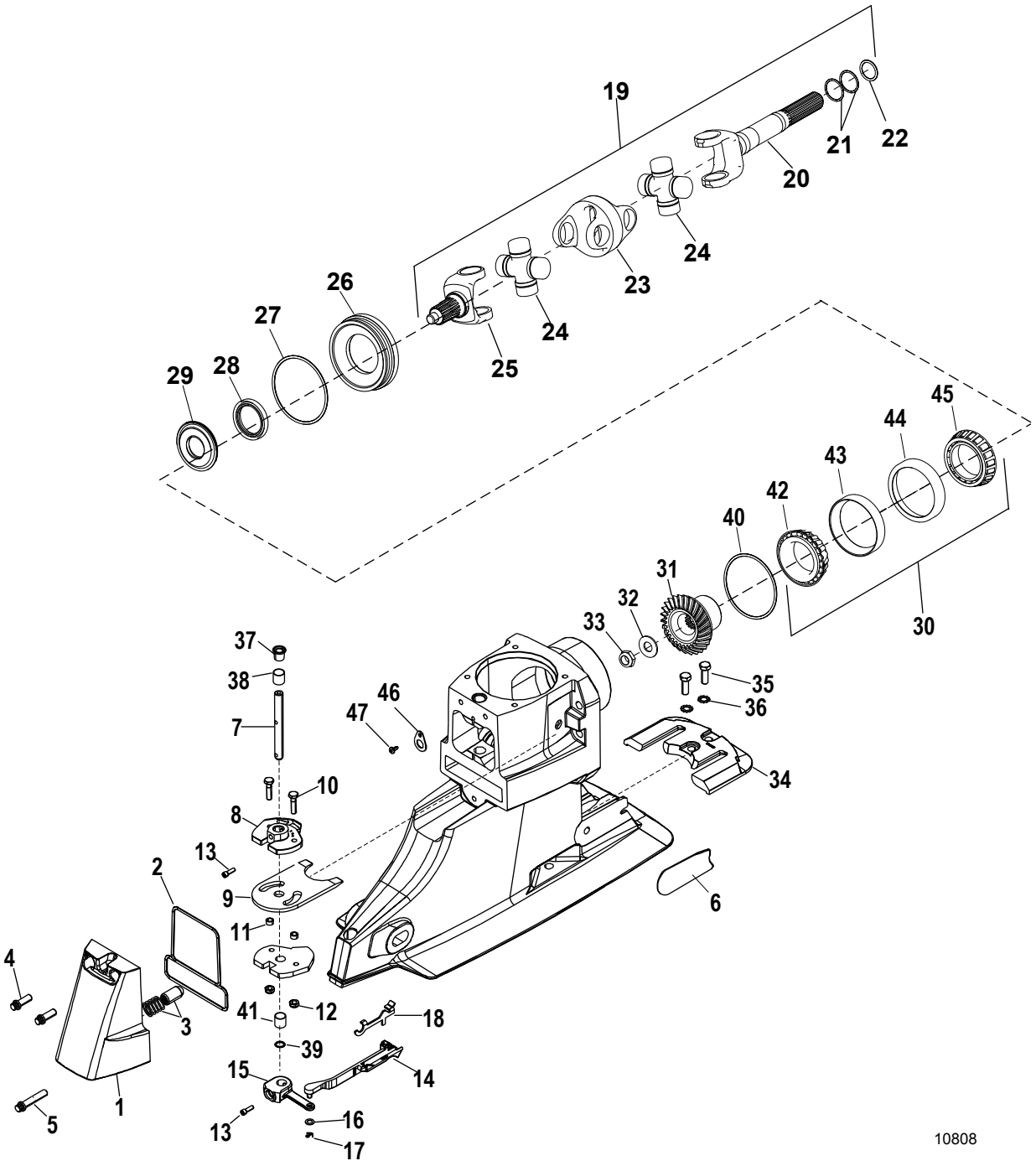
1 - Driveshaft housing
2 - Stud (4)
3 - Water passage seal
4 - O-ring
5 - Bearing race
6 - Needle bearing
7 - Shift shaft oil seal plug
8 - Upper shift shaft bushing
9 - Shift shaft seal
10 - Vent plug
11 - Vent plug seal
12 - Top cover (standard)
13 - Bearing sleeve
14 - Needle bearing
15 - Top cover O-ring
16 - Top cover screws (4) (standard)
17 - Thrust race
18 - Ball check assembly
19 - Thrust bearing
20 - Upper driven gear
21 - Garter spring thrust bearing
22 - Clutch
23 - Garter spring
24 - Upper driveshaft
25 - Thrust collar
26 - Keepers
27 - Washer
28 - Plug
29 - Nut
30 - Trim-in insert
31 - Top cover screws (X Series)
32 - Top cover (X Series)
33 - Lower shift shaft bushing
34 - Washers
35 - Grounding tab
36 - Self tapping screw

Driveshaft Housing U-Joint and Shift Components for Standard Bravo Models



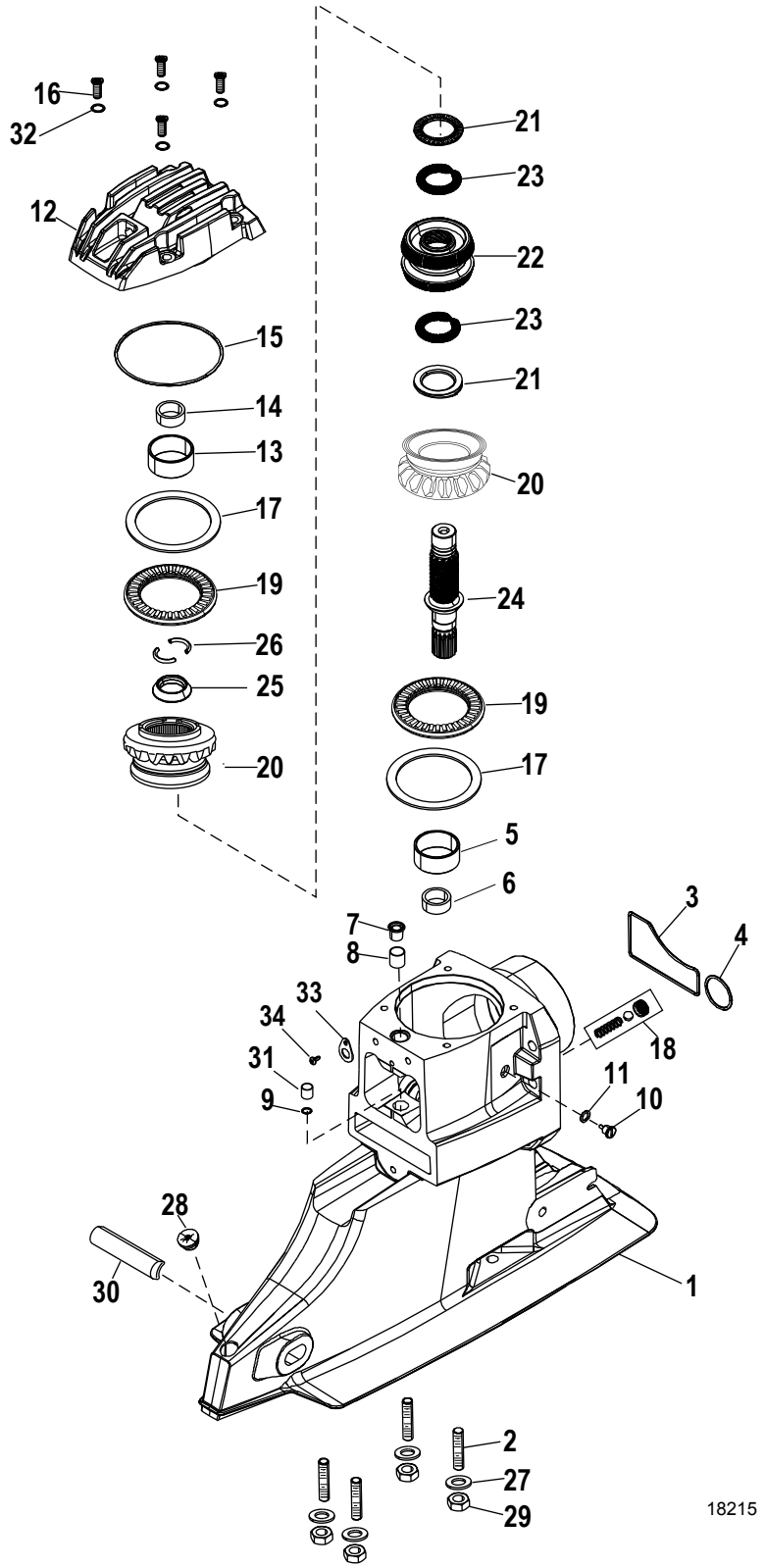
1 - Back cover
2 - Back cover seal
3 - Detent assembly
4 - Back cover short bolt
5 - Back cover long bolt
6 - Wear pad
7 - Shift shaft
8 - Cam
9 - Yoke
10 - Cam screws
11 - Spacer
12 - Nut
13 - Screw
14 - Link bar
15 - Shift lever
16 - Washer
17 - Cotter pin
18 - Latch
19 - U-joint assembly
20 - Yoke (coupler end)
21 - O-rings
22 - O-ring
23 - Socket
24 - Cross and bearing assembly
25 - Yoke (gear end)
26 - Retainer nut
27 - O-ring
28 - Oil seal
29 - Preload washer
30 - O-ring
31 - Sealing ring
32 - U-joint bearing assembly
33 - Pinion gear
34 - Washer
35 - Nut
36 - Anode plate
37 - Screws
38 - Washers
39 - Shift shaft oil seal plug
40 - Upper shift shaft bushing
41 - Seal
42 - Shim
43 - Lower shift shaft bushing
44 - Tapered roller bearing
45 - Flanged bearing cup
46 - Bearing cup
47 - Tapered roller bearing
48 - Grounding tab
49 - Self tapping screw

Driveshaft Housing U-Joint and Shift Components for X Series Models



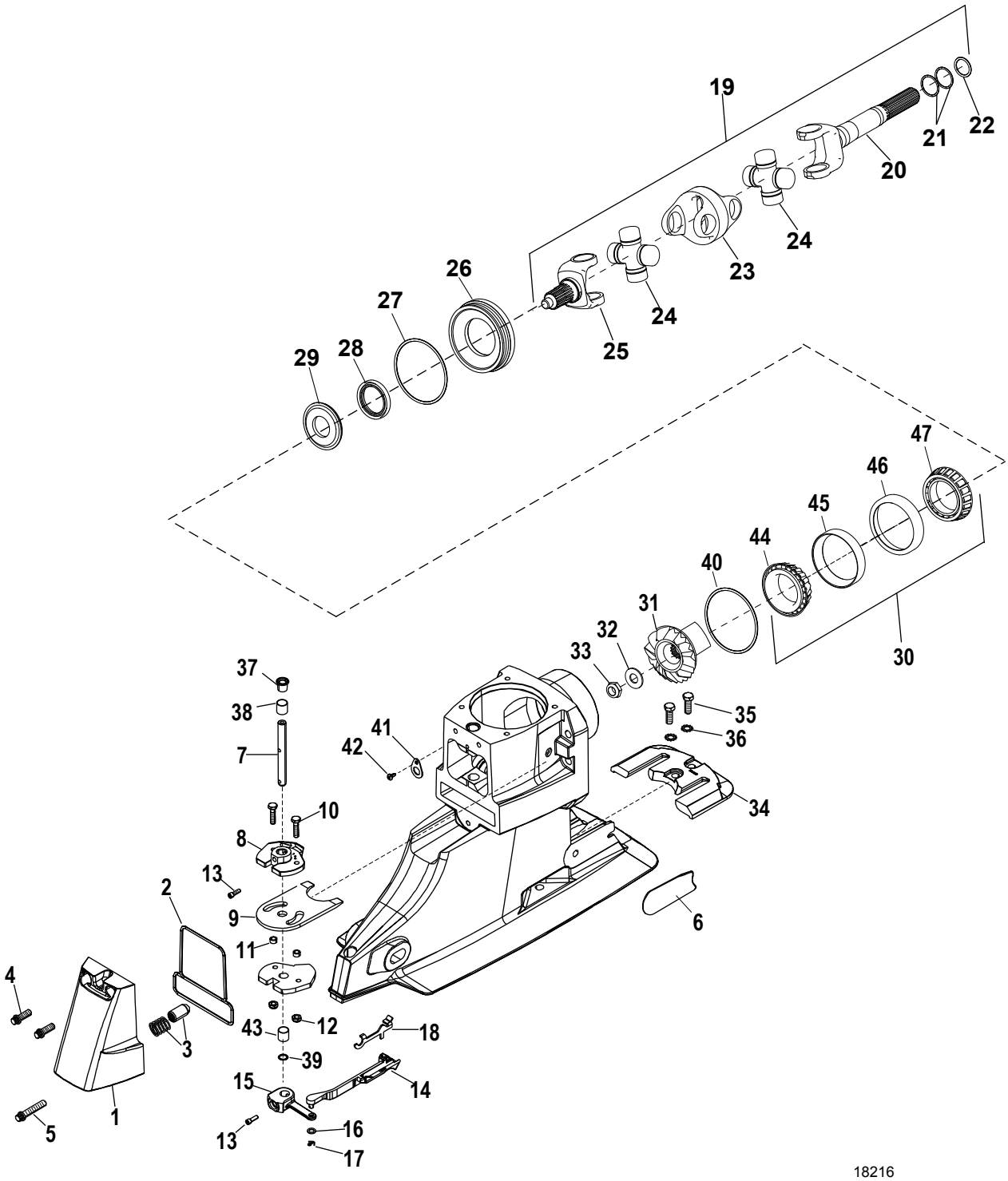
1 - Back cover
2 - Back cover seal
3 - Detent assembly
4 - Back cover short bolt
5 - Back cover long bolt
6 - Wear pad
7 - Shift shaft
8 - Cam
9 - Yoke
10 - Cam screws
11 - Spacer
12 - Nut
13 - Screw
14 - Link bar
15 - Shift lever
16 - Washer
17 - Cotter pin
18 - Latch
19 - U-joint assembly
20 - Yoke (coupler end)
21 - O-rings
22 - O-ring
23 - Socket
24 - Cross and bearing assembly
25 - Yoke (gear end)
26 - Retainer nut and oil seal carrier
27 - O-ring
28 - Oil seal
29 - Preload washer
30 - U-joint bearing assembly
31 - Pinion gear
32 - Washer
33 - Nut
34 - Anode plate
35 - Screw
36 - Washer
37 - Shift shaft oil seal plug
38 - Upper shift shaft bushing
39 - Seal
40 - Shim
41 - Lower shift shaft bushing
42 - Tapered roller bearing
43 - Flanged bearing cup
44 - Bearing cup
45 - Tapered roller bearing
46 - Grounding tab
47 - Self tapping screw

Driveshaft Housing and Gears for XR Models



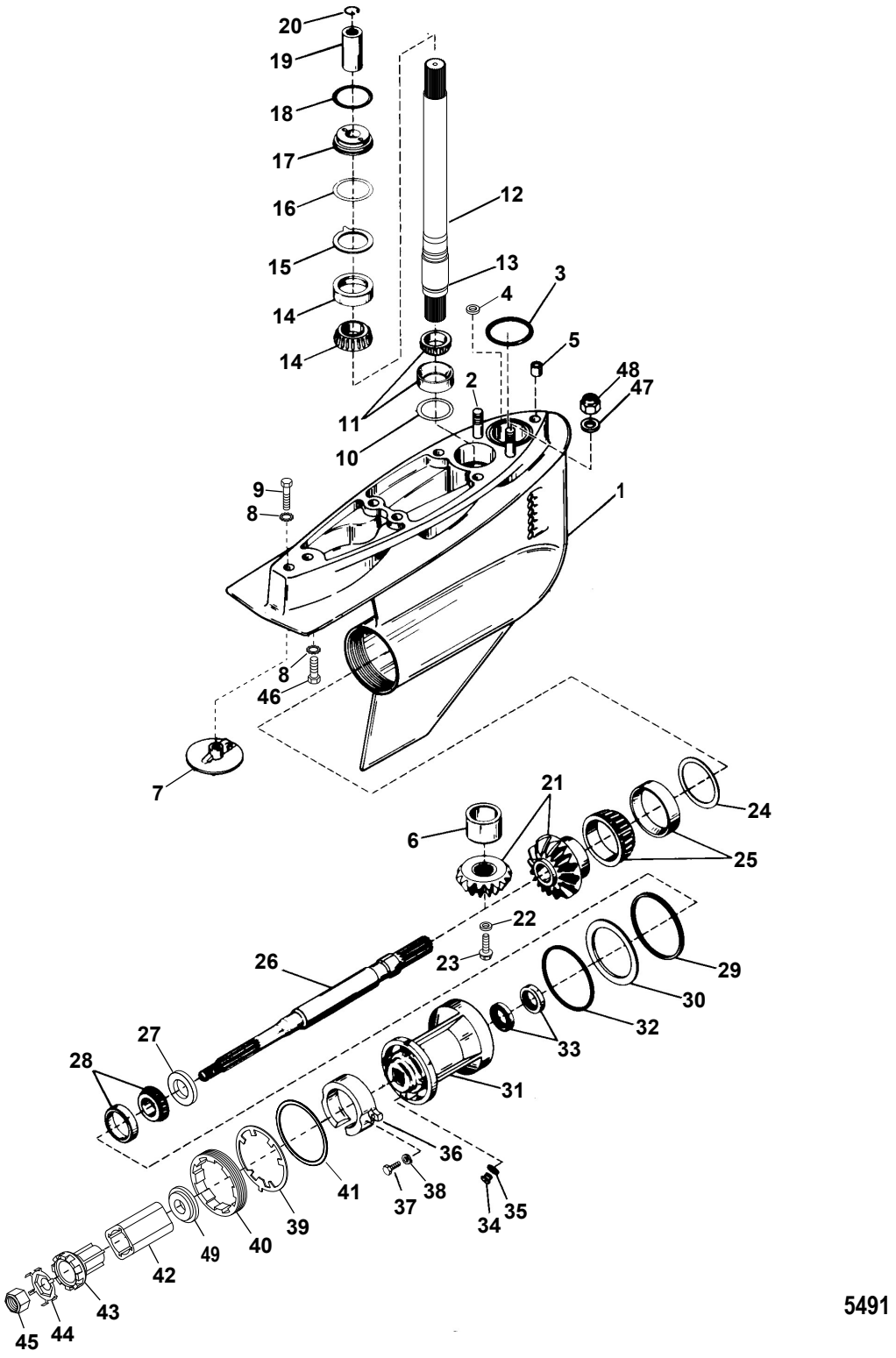
1 - Driveshaft housing
2 - Stud (4)
3 - Water passage seal
4 - O-ring
5 - Bearing sleeve
6 - Needle bearing
7 - Shift shaft oil seal plug
8 - Upper shift shaft bushing
9 - Shift shaft seal
10 - Vent plug
11 - Vent plug seal
12 - Top cover (standard)
13 - Bearing sleeve
14 - Needle bearing
15 - Top cover O-ring
16 - Top cover screws (4)
17 - Thrust race
18 - Ball check assembly
19 - Thrust bearing
20 - Upper driven gear assembly
21 - Thrust bearing
22 - Clutch
23 - Garter spring
24 - Upper driveshaft
25 - Thrust collar
26 - Keepers
27 - Washer
28 - Plug
29 - Nut
30 - Trim-in insert
31 - Lower shift shaft bushing
32 - Washers
33 - Grounding tab
34 - Self tapping screw

Driveshaft Housing U-Joint and Shift Components for XR Models



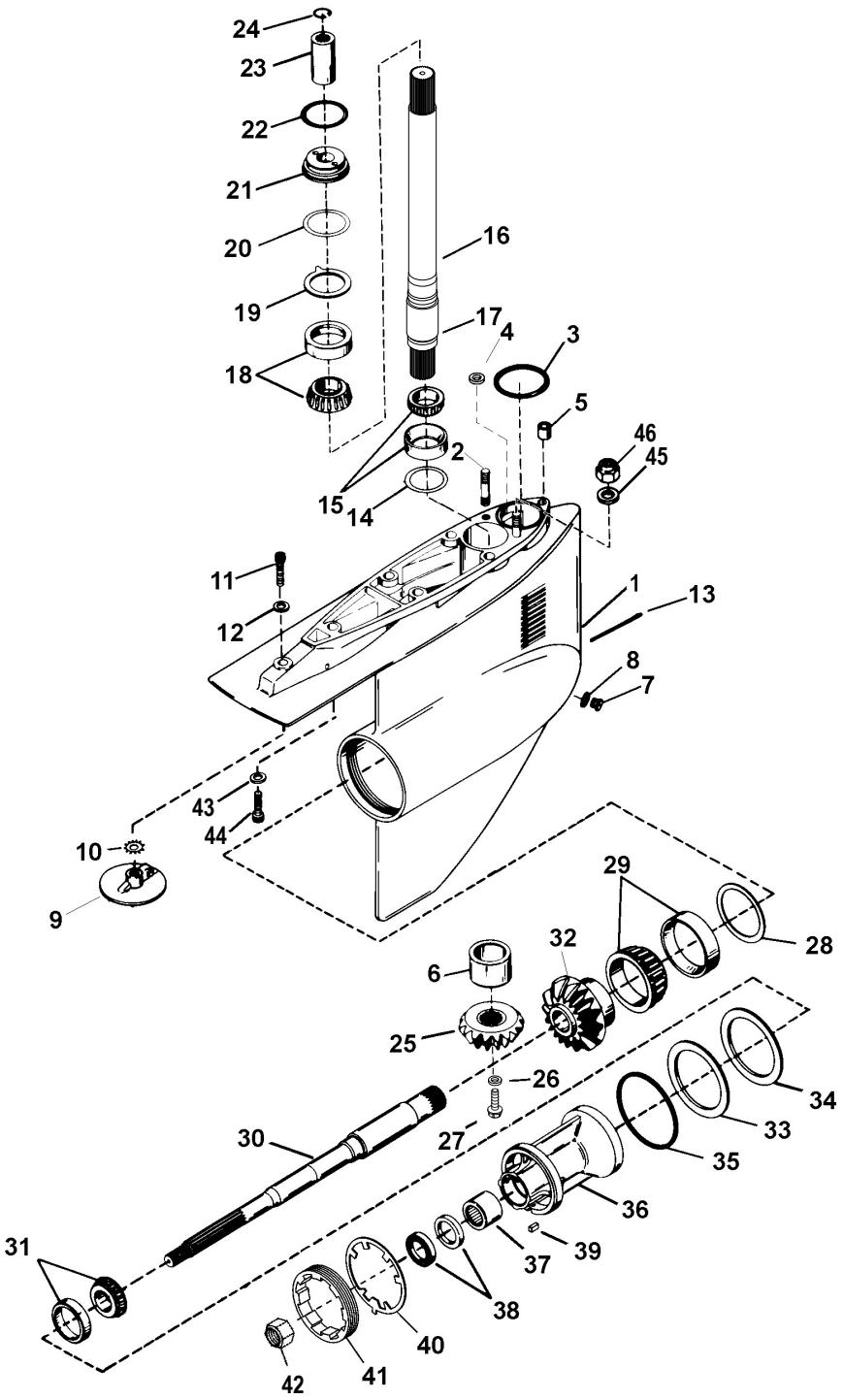
1 - Back cover
2 - Back cover seal
3 - Detent assembly
4 - Back cover short bolt
5 - Back cover long bolt
6 - Wear pad
7 - Shift shaft
8 - Cam
9 - Yoke
10 - Cam screws
11 - Spacer
12 - Nut
13 - Shift shaft screw
14 - Link bar
15 - Shift lever
16 - Washer
17 - Cotter pin
18 - Latch
19 - U-joint assembly
20 - Yoke (coupler end)
21 - O-rings
22 - O-ring
23 - Socket
24 - Cross and bearing assembly
25 - Yoke (gear end)
26 - Retainer nut
27 - O-ring
28 - Oil seal
29 - Preload washer
30 - U-joint bearing assembly
31 - Pinion gear
32 - Washer
33 - Nut
34 - Anode plate
35 - Screws
36 - Washers
37 - Shift shaft oil seal plug
38 - Upper shift shaft bushing
39 - Seal
40 - Shim
41 - Grounding tab
42 - Self-tapping screw
43 - Lower shift shaft bushing
44 - Tapered roller bearing
45 - Flanged bearing cup
46 - Bearing cup
47 - Tapered roller bearing

Bravo One Gear Housing - Exploded View



1 - Gear housing assembly
2 - Stud
3 - O-ring
4 - Seal
5 - Seal
6 - Roller bearing assembly
7 - Anodic plate assembly
8 - Lockwasher
9 - Screw
10 - Shim kit
11 - Tapered roller bearing assembly
12 - Driveshaft assembly
13 - Bearing race
14 - Tapered roller bearing assembly
15 - Tab washer
16 - Shim kit
17 - Spacer
18 - O-ring
19 - Coupling assembly
20 - Retaining ring
21 - Gear set
22 - Washer
23 - Screw
24 - Shim kit
25 - Tapered roller bearing assembly
26 - Propeller shaft
27 - Washer
28 - Tapered roller bearing assembly
29 - Load ring
30 - Thrust washer
31 - Bearing carrier assembly
32 - O-ring
33 - Seal
34 - Drain plug kit
35 - Seal
36 - Anode assembly
37 - Screw
38 - Lockwasher
39 - Tab washer
40 - Bearing carrier retainer
41 - Spacer
42 - Plastic drive sleeve
43 - Aft propeller sleeve brass adaptor
44 - Tab washer
45 - Propeller nut kit
46 - Screw
47 - Washer
48 - Nut
49 - Thrust hub

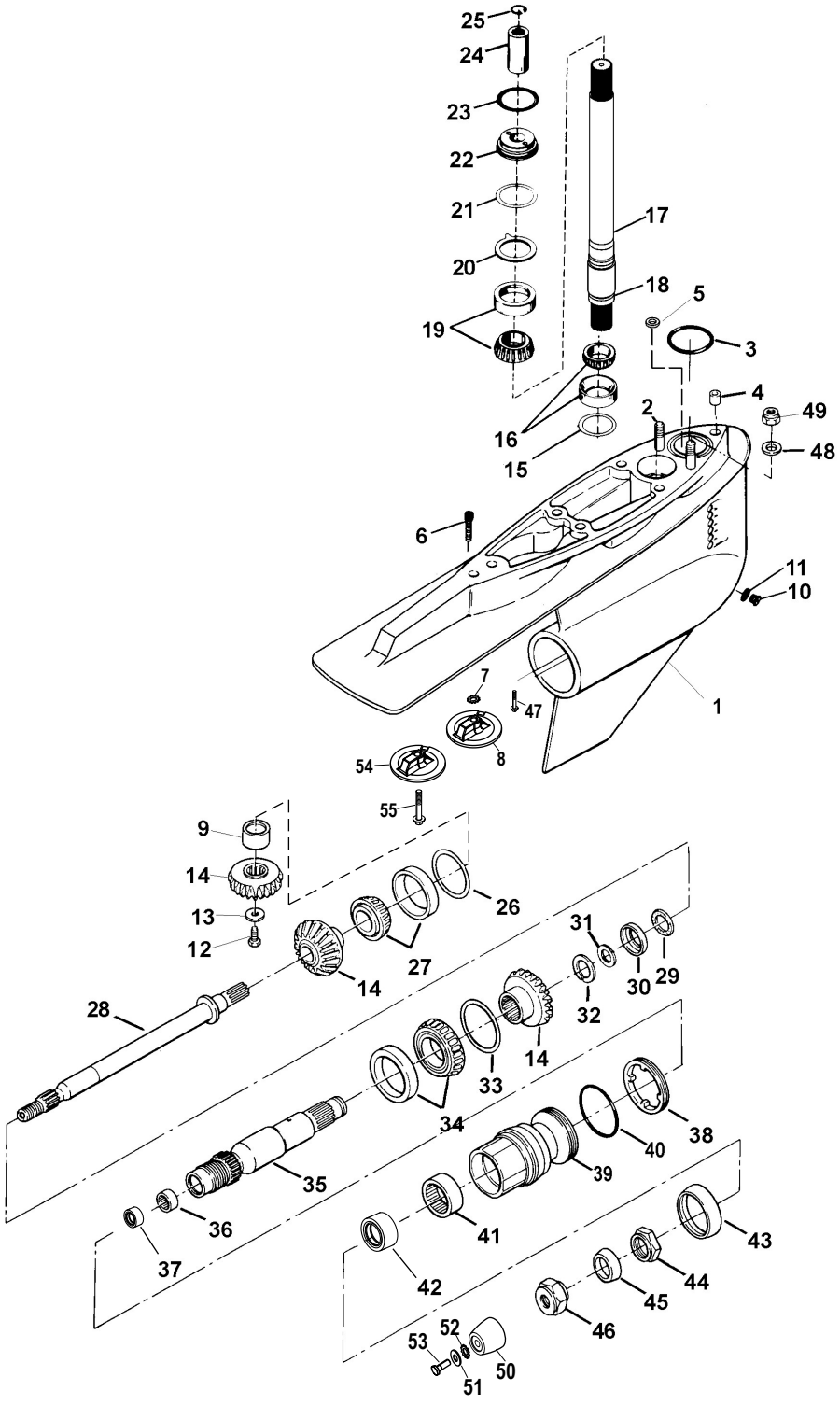
Bravo Two Gear Housing - Exploded View



5501

1 - Gear housing assembly
2 - Stud
3 - O-ring
4 - Seal
5 - Seal
6 - Roller bearing assembly
7 - Drain plug kit
8 - Seal
9 - Anodic plate assembly
10 - Lockwasher
11 - Screw
12 - Washer
13 - Speedometer pickup tube
14 - Shim kit
15 - Tapered roller bearing assembly
16 - Driveshaft assembly
17 - Bearing race
18 - Tapered roller bearing assembly
19 - Tab washer
20 - Shim kit
21 - Spacer
22 - O-ring
23 - Coupling assembly
24 - Retaining ring
25 - Pinion gear
26 - Pinion gear washer
27 - Pinion gear screw
28 - Shim assembly
29 - Tapered roller bearing assembly
30 - Propeller shaft
31 - Tapered roller bearing assembly
32 - Driven gear
33 - Thrust ring
34 - Load ring
35 - O-ring
36 - Bearing carrier assembly
37 - Roller bearing
38 - Fish-line cutter oil seal and oil seal
39 - Key
40 - Tab washer
41 - Cover
42 - Propeller nut
43 - Screw
44 - Lockwasher
45 - Washer
46 - Nut

Bravo Three Gear Housing



1 - Gear housing assembly
2 - Stud
3 - O-ring
4 - Seal
5 - Seal
6 - Screw
7 - Lockwasher
8 - Anodic plate assembly
9 - Roller bearing assembly
10 - Drain plug kit
11 - Seal
12 - Screw
13 - Washer
14 - Gear set
15 - Shim kit
16 - Tapered roller bearing assembly
17 - Driveshaft assembly
18 - Bearing race
19 - Tapered roller bearing assembly
20 - Tab washer
21 - Shim kit
22 - Spacer
23 - O-ring
24 - Coupling assembly
25 - Retaining ring
26 - Shim kit
27 - Tapered roller bearing assembly
28 - Inner propeller shaft
29 - Thrust bearing
30 - Bushing
31 - Shim assembly
32 - Retaining ring
33 - Shim assembly
34 - Tapered roller bearing assembly
35 - Outer propeller shaft
36 - Roller bearing
37 - Oil seal
38 - Retainer
39 - Bearing carrier assembly
40 - O-ring
41 - Roller bearing
42 - Oil seal
43 - Front thrust hub
44 - Front propeller nut
45 - Rear thrust hub
46 - Rear propeller nut
47 - Screw
48 - Washer
49 - Nut
50 - Propeller shaft anode kit
51 - Flat washer
52 - Internal tooth lockwasher
53 - Screw
54 - Anode
55 - Screw

Bravo Drive Unit Service

Section 8B - Bravo Driveshaft Housing Set Up - Earlier Models (Serial Number 0M198372 and Below)

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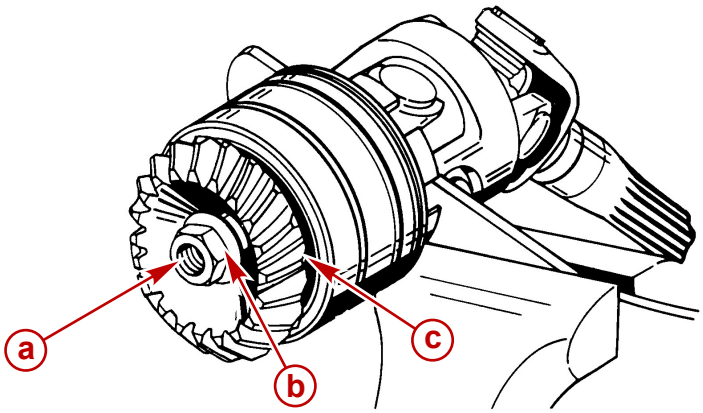
Bravo Driveshaft Housing Shimming/Setup Procedures

Assemble U-joint bearings as instructed.

NOTE: *Spacer between bearing cups must be free to move. Do not over press, as damage to both bearings could occur.*

Secure pinion gear assembly to shaft with washer and new nut. Tighten nut to the point where washer just touches gear.



20276

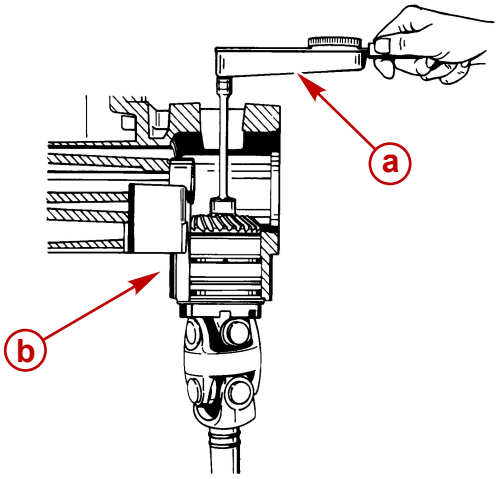
a - Nut
b - Washer
c - Pinion gear assembly

Set the preload on bearing package as follows (two assembly holding methods shown):

Method #1

Mount upper driveshaft housing in bench holding fixture.

Install U-joint assembly into housing and secure with retainer nut.



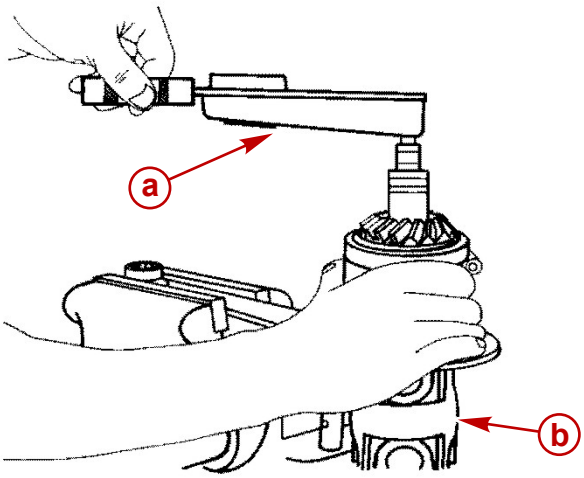
20277

a - Torque wrench (lb. in. – Dial Indicator)
b - Driveshaft housing (U-joint shaft hanging straight down)

Method #2

Mount retainer nut wrench in vise to support U-joint assembly.

Install U-joint assembly into wrench, with shaft pointing straight down.



20280

a - Torque wrench (lb-in.)

b - U-joint shaft (hanging straight down)

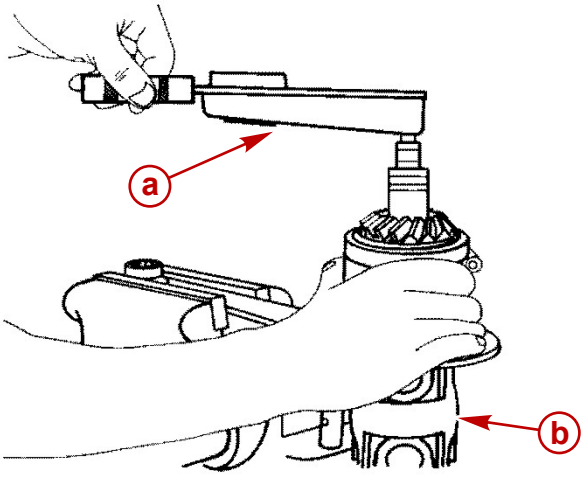
Set preload by tightening nut 1/16 of a turn at a time.

After each tightening check for proper preload by turning pinion gear, using an appropriate socket and torque wrench (lb-in. - with Dial Indicator), until acceptable torque is obtained.

If nut becomes over-tightened (causing excessive preload), loosen nut a number of turns and gently strike pinion end of U-joint shaft using a soft hammer. Repeat adjustment procedure.

Description	New Bearings	Used Bearings*
U-joint Bearing Preload	0.7-1.0 Nm (6-10 lb. in.)	0.3-0.8 Nm (3-7 lb. in.)

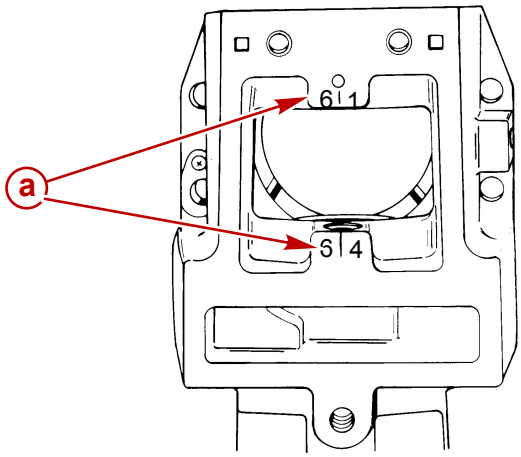
*Bearings are **used** if spun once under load.



20280

a - Torque wrench (lb-in. - with Dial Indicator) being used to check preload

b - U-joint shaft hanging straight down



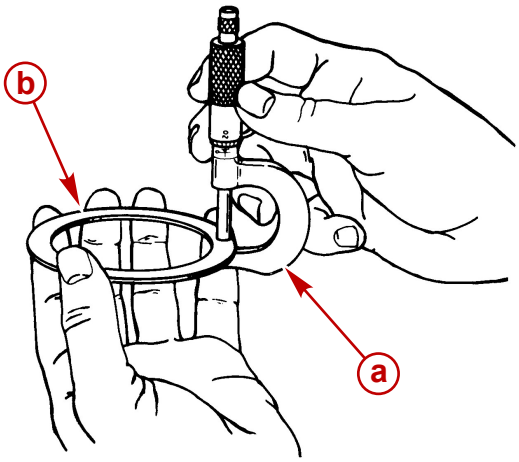
20281

a - Stamped number

The stamped number designates the thickness of the top and bottom thrust bearing races.

NOTE: *If using the original thrust bearing race, install race so that side with original contact area faces bearing.*

If the upper and lower thrust bearing races get mixed up they should be checked with a micrometer for thickness, to correspond with the housing stamped numbers.

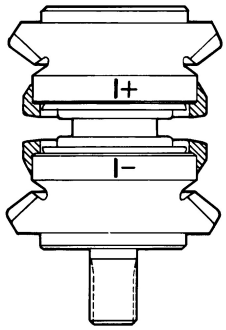


20282

a - Micrometer

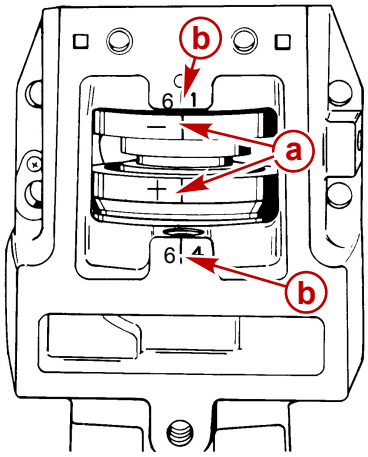
b - Thrust bearing race

IMPORTANT: Timing marks on clutch gears must be aligned in one of two ways. The positive (+) mark over the negative (–) or the negative (–) mark over the positive (+). Never align two positive (+) marks or two negative (–) marks.



20283

Align clutch gear timing marks with index marks on driveshaft housing as closely as possible.



20284

a - Timing marks **b -** Index marks

Bravo Drive Unit Service

Section 8C - Bravo Driveshaft Housing Set Up - Later Models (Serial Number 0M198373 and Above)

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8C

Bravo Driveshaft Housing Activity

The object of the activity is to review and/or perform the subjects in the Service Manual #28 and the Supplement and be able to answer the related questions on the Bravo Shimmable Driveshaft Housing activity sheet.

Specifications

Starting Shim Specification

Starting thrust race specification	mm	in.
Driven gear thrust race	1.63	0.064

Starting thrust race specification	mm	in.
U-joint pinion gear shim	0.09	0.035

Gear Tooth Count and Gear Lash

Pinion (drive) gear tooth	Driven gear tooth	Driveshaft housing gear lash
27	32	0.28–0.41 mm (0.011–0.016 in.)
27	29	0.33–0.46 mm (0.013–0.018 in.)
23	30	0.28–0.41 mm (0.011–0.016 in.)
16	19	0.23–0.38 mm (0.009–0.015 in.)

U-joint Pinion Gear Location

Specification	mm	in.
Pinion gear location	0.64	0.025

U-joint Pinion Gear Shim

U-joint pinion gear shim	mm	in.
15-888927-028	0.71	0.028
15-888927-029	0.74	0.029
15-888927-030	0.76	0.030
15-888927-031	0.79	0.031
15-888927-032	0.81	0.032
15-888927-033	0.83	0.033
15-888927-034	0.86	0.034
15-888927-035	0.89	0.035
15-888927-036	0.91	0.036
15-888927-037	0.97	0.037
15-888927-038	0.97	0.038
15-888927-039	0.99	0.039
15-888927-040	1.02	0.040

Driven Gear Thrust Race

Thrust bearing race	Thickness	Color code
23-864596-058	1.47 mm (0.058 in.)	Brown
23-864596-059	1.50 mm (0.059 in.)	White
23-864596-060	1.52 mm (0.060 in.)	Orange
23-864596-061	1.55 mm (0.061 in.)	Green
23-864596-062	1.57 mm (0.062 in.)	Yellow
23-864596-063	1.60 mm (0.063 in.)	Red
23-864596-064	1.63 mm (0.064 in.)	Light Blue
23-864596-065	1.65 mm (0.065 in.)	Black
23-864596-066	1.68 mm (0.066 in.)	Pink
23-864596-067	1.70 mm (0.067 in.)	Purple

General Information

⚠ CAUTION

Improper gear adjustment can cause severe damage to the sterndrive. Follow the gear adjustment procedure closely.

All Bravo drives with the starting Serial Number of 0M198373 and above, must be shimmed during reassembly of the driveshaft housing.

Assembly Changes

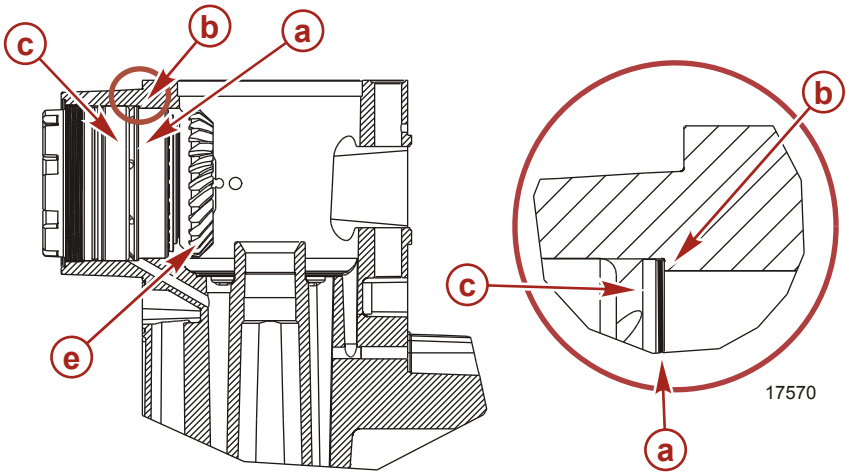
U-JOINT SHIM

The U-joint assembly is shimmed for gear depth and location.

NOTE: *The shim is between the shoulder of the U-joint snout and the flanged bearing cup.*

When the driveshaft housing is assembled, the shim fits between the flanged bearing cup and the shoulder of the U-joint snout.

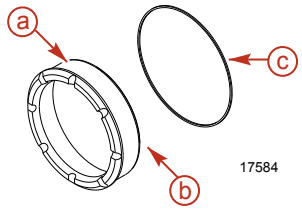
Adding shim thickness positions the pinion (drive) gear farther away from the driven gear and removing shim thickness positions the pinion (drive) gear closer to the driven gear.



Driveshaft housing cut showing shim and gear placement

- **a -** Shims position on the flanged bearing cup
- **b -** Shoulder of the U-joint snout
- **c -** Shoulder of the flanged bearing cup
- **d -** U-joint retainer nut (standard Bravo)
- **e -** Pinion (drive) gear

The flanged bearing cup replaces the smaller outside diameter bearing cup and spacer of the pinion (drive) gear and bearing assembly.



a - Flanged bearing cup
b - Shoulder
c - Shim

During reassembly of the driveshaft housing, use the original shim thickness that came out of the drive or use the shim thickness listed in the starting point specification chart below.

Starting shim specification	mm	in.
U-joint pinion gear shim	0.09	0.035

Shims graduate in 0.025 mm (0.001 in.) thickness.

U-joint pinion gear shim	mm	in.
15-888927-028	0.71	0.028
15-888927-029	0.74	0.029
15-888927-030	0.76	0.030
15-888927-031	0.79	0.031
15-888927-032	0.81	0.032
15-888927-033	0.83	0.033
15-888927-034	0.86	0.034
15-888927-035	0.89	0.035
15-888927-036	0.91	0.036
15-888927-037	0.94	0.037
15-888927-038	0.97	0.038
15-888927-039	0.99	0.039
15-888927-040	1.02	0.040

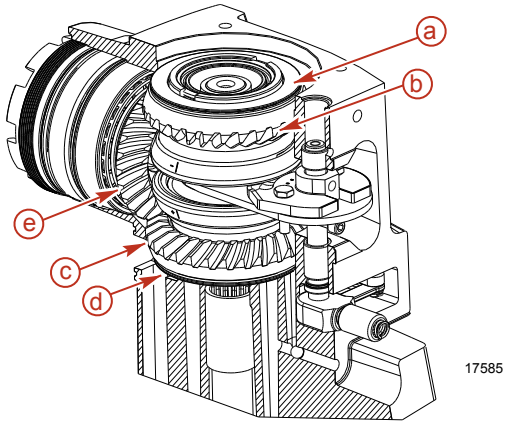
DRIVEN GEAR SHIM

The driven gears are set by measuring the gear lash of the pinion (drive) gear to each driven gear.

Driven gears in the driveshaft housing are shimmed into position by using the correct upper and lower thrust race thickness.

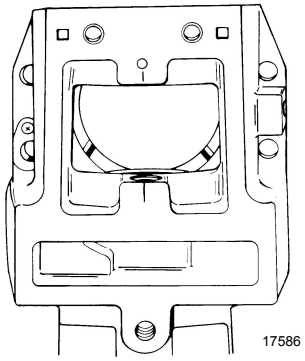
Therefore adding upper thrust race thickness positions the upper driven gear closer to the pinion gear thereby reducing gear lash. Consequently, removing upper thrust race thickness positions the upper driven gear farther away from the pinion gear, increasing gear lash.

Adding lower thrust race thickness positions the lower driven gear closer to the pinion gear, reducing gear lash. Removing lower thrust race thickness positions the lower driven gear farther away from the pinion gear, increasing gear lash.



a - Upper thrust race
b - Upper driven gear
c - Lower driven gear
d - Lower thrust race
e - Pinion (drive) gear

The driveshaft housing is no longer stamped to indicate the thickness of the upper and lower thrust race.



During reassembly of the driveshaft housing, use the original thrust race thickness that came out of the drive or use the thrust race thickness in the starting point specification chart.

Starting thrust race specification	mm	in.
Driven gear thrust race	1.63	0.064

Thrust race are color coded and graduate in 0.025 mm (0.001 in.) thickness.

Thrust bearing race	Thickness	Color code
23-864596-058	1.47 mm (0.058 in.)	Brown
23-864596-059	1.50 mm (0.059 in.)	White
23-864596-060	1.52 mm (0.060 in.)	Orange
23-864596-061	1.55 mm (0.061 in.)	Green
23-864596-062	1.57 mm (0.062 in.)	Yellow
23-864596-063	1.60 mm (0.063 in.)	Red
23-864596-064	1.63 mm (0.064 in.)	Light Blue
23-864596-065	1.65 mm (0.065 in.)	Black
23-864596-066	1.68 mm (0.066 in.)	Pink
23-864596-067	1.70 mm (0.067 in.)	Purple

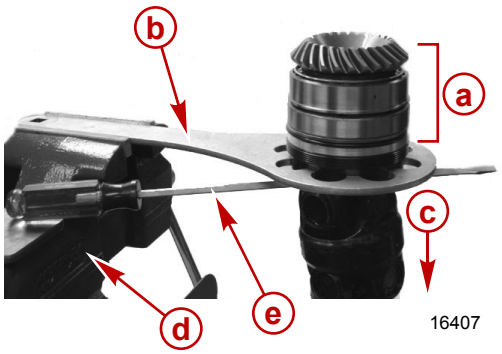
Driveshaft Housing Assembly: Teardown, Inspection and Repair

U-joint Pinion Gear and Bearing Assembly Preload

Follow only one of the procedures: **Setting Preload Using a Vise, Setting Preload In The Driveshaft Housing.**

SETTING PRELOAD USING A VISE

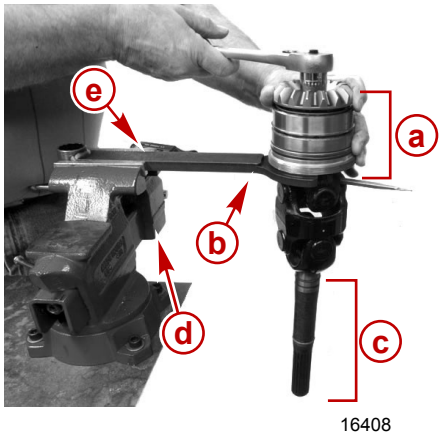
1. Set the preload on bearing package as follows:
   a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly.
   b. Position the U-joint assembly with its shaft facing down as shown.



Standard Bravo

- **a -** U-joint pinion gear and bearing assembly
- **b -** Bearing retainer wrench
- **c -** U-joint shaft (facing down)
- **d -** Vise
- **e -** Screwdriver

Bearing retainer wrench	91-17256



Bravo X series

- **a -** U-joint pinion gear and bearing assembly
- **b -** Bearing retainer wrench
- **c -** U-joint shaft (facing down)
- **d -** Vise
- **e -** Screwdriver

Spanner wrench for L-18 U-joint bearing retainer	91-862219A1

   c. Apply a light coat of lubricant to bearings.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bearings	92-802854A1

d. Set preload by tightening the nut 1/16 of a turn at a time.

e. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and a dial torque wrench lb. in. until you reach the specified torque.

⚠ CAUTION

Avoid premature bearing failure. Do not overtighten the U-joint pinion gear nut.

16409

Standard Bravo shown Bravo X series similar

a - Dial type torque wrench (lb. in.)

NOTE: *Bearings are used if spun once under load.*

Description	New	Used
U-joint bearing preload	0.7–1.0 Nm (6–10 lb. in.)	0.3–0.8 Nm (3–7 lb. in.)

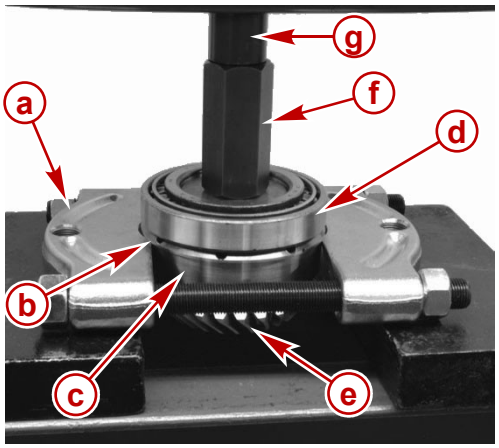
Torque wrench, lb. in.	91-66274

2. **If the nut becomes overtightened (causing excessive preload),** release the pinion gear and bearing assembly preload.

   a. Remove the pinion gear and the bearing assembly from the U-joint.

   b. Place the universal puller plate under the shoulder of the flanged bearing cup.

c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure.



16412

a - Universal puller plate tool
b - Flanged bearing cup shoulder
c - Flanged bearing cup
d - Top roller bearing and bearing cup
e - Pinion gear
f - Mandrel on pinion gear
g - Press on mandrel

Universal puller plate	91-37241

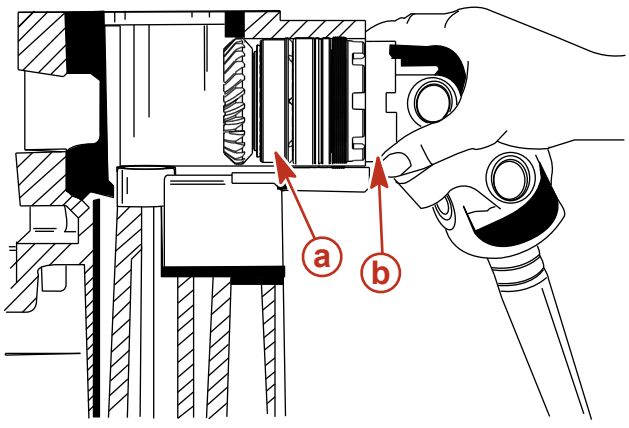
d. Reassemble the components of the U-joint and repeat the preload procedures.

SETTING PRELOAD IN THE DRIVESHAFT HOUSING

1. Set the preload on a U-joint pinion gear-and-bearing assembly as follows:
   a. Apply a light coat of lubricant to bearings.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bearings	92-802854A1

   b. Install the U-joint and pinion gear assembly into the driveshaft housing.



16414

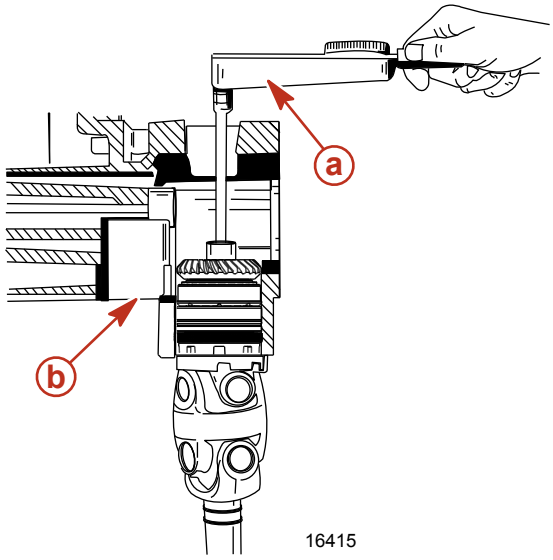
Standard Bravo shown Bravo X series similar

a - U-joint and pinion gear assembly
b - Retaining nut

   c. Position the driveshaft housing so that the U-joint coupling shaft is pointing straight down.
   d. Set the preload by tightening the nut 1/16 of a turn at a time. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and dial torque wrench until you reach an acceptable torque.

⚠ CAUTION

Premature bearing failure can result if U-joint pinion gear nut becomes overtightened (causing excessive preload).



Standard Bravo shown Bravo X series similar

a - Dial torque wrench (lb. in.)

b - Driveshaft housing (U-joint shaft facing down)

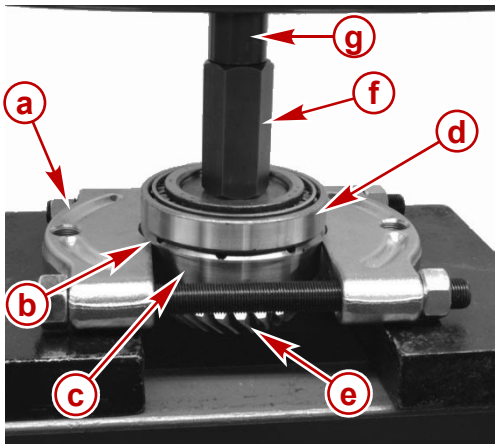
NOTE: *Bearings are used if spun once under load*

Description	New	Used
U-joint bearing preload	0.7–1.0 Nm (6–10 lb. in.)	0.3–0.8 Nm (3–7 lb. in.)

Torque wrench, lb. in.	91-66274

2. Remove U-joint and pinion gear assembly from driveshaft housing.
3. **If nut becomes overtightened (causing excessive preload)**, release the pinion gear and bearing assembly preload:
   a. Remove the pinion gear and bearing assembly from the U-joint.
   b. Place the universal puller plate under the shoulder of the flanged bearing cup.

c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure.



16412

a - Universal puller plate tool
b - Flanged bearing cup shoulder
c - Flanged bearing cup
d - Top roller bearing and bearing cup
e - Pinion gear
f - Mandrel on pinion gear
g - Press on mandrel

Universal puller plate	91-37241

d. Reassemble components to the U-joint and repeat preload procedures.

Driveshaft Housing Shimming Preparation For Assembly

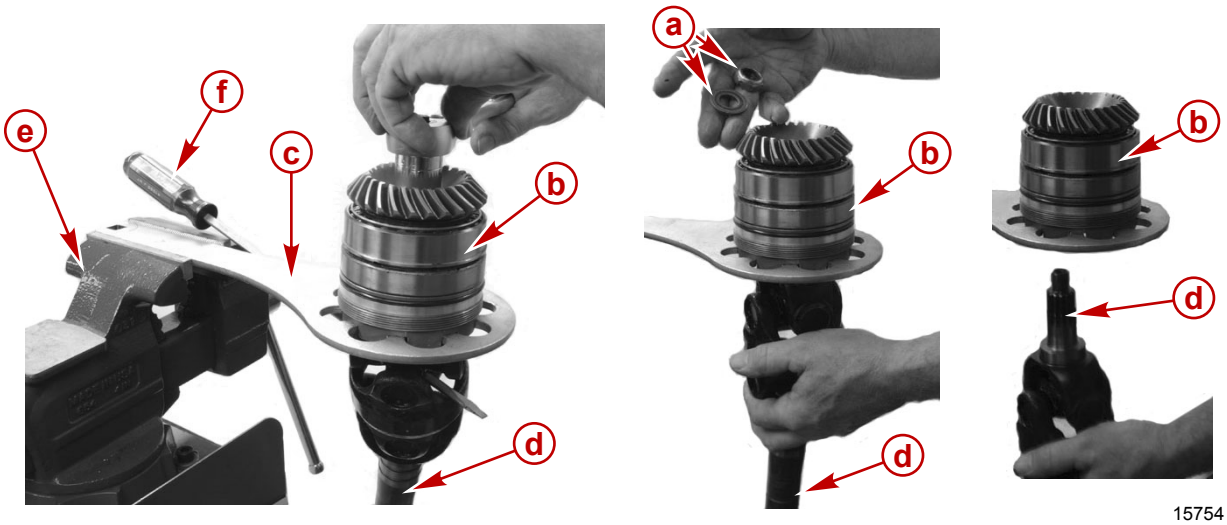
U-joint Pinion Gear Shimming

⚠ CAUTION

Avoid injury. Heavy sterndrive components may come apart suddenly and forcefully, possibly resulting in injury. Properly support the U-joint yoke assembly while removing the pinion gear nut.

1. Ensure that the U-joint pinion gear and bearing assembly preload is set and ready to install.
2. Disassemble U-joint from pinion gear and bearing assembly:
   a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly.
   b. Position the U-joint assembly with shaft pointing straight down.
   c. Use a long screwdriver to secure the U-joint so that it will not rotate while loosing the nut.
   d. Remove screwdriver.

e. The U-joint will fall when nut is removed. Hold the U-joint and remove the nut and washer.



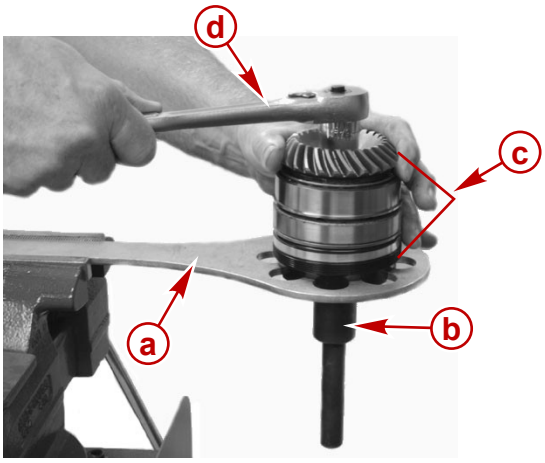
a - Retainer nut and washer
b - U-joint pinion gear and bearing assembly
c - Bearing retainer wrench tool
d - U-joint shaft
e - Vise
f - Screwdriver

Bearing retainer wrench	91-17256

3. Insert the stub shaft tool from the bottom of the the pinion gear and bearing assembly, and the remaining components.

NOTE: *Do not overtighten the nut.*

4. Install the washer and nut; tighten nut until the washer and nut just seat against the pinion gear and the complete assembly is firmly seated to the stub shaft tool.



Standard Bravo U-joint assembly shown

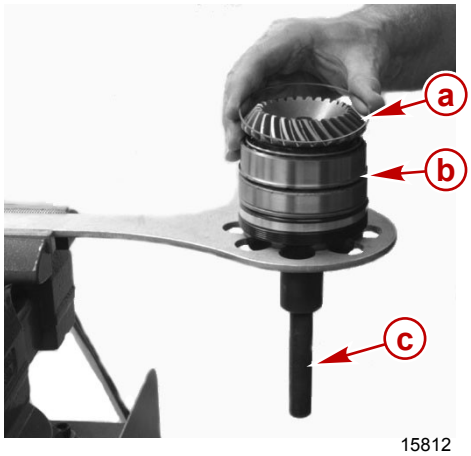
a - Tool
b - Stub shaft tool
c - Pinion gear and bearing assembly
d - Socket on nut

Stub shaft for Standard Bravo	91-865084

Stub shaft for Bravo X Series	91-865083

5. Position the shim on the shoulder of the flanged bearing cup. Use the starting shim specification chart or the original shim thickness that came out of the drive as a starting point.

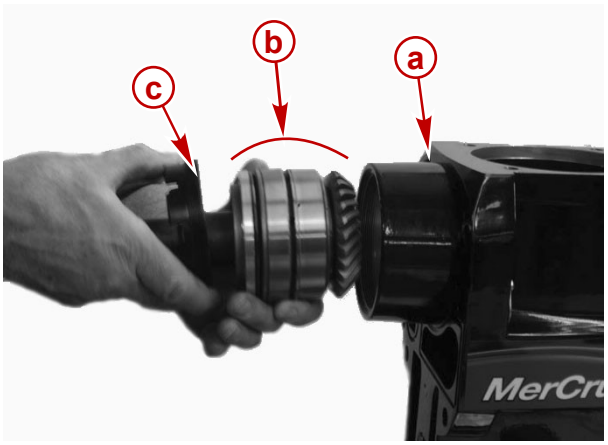
Starting shim specification	mm	in.
U-joint pinion gear shim	0.09	0.035



15812

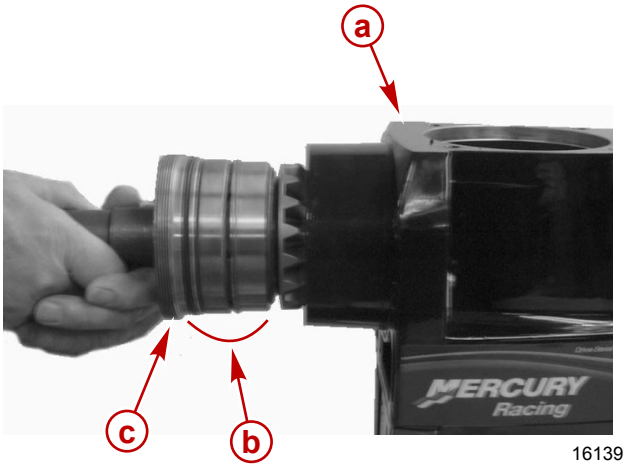
a - Shim
b - Shoulder of bearing spacer cup
c - Stub shaft tool

6. Carefully install the pinion gear and bearing assembly with the stub shaft tool into the driveshaft housing bore so not to damage the shim.



15813

Standard Bravo



16139

Bravo XR

a - Driveshaft housing
b - Stub shaft tool complete assembly
c - Retainer nut

7. Apply lubricant to the threads of the retainer nut.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Threads of retainer nut	92-802865A1

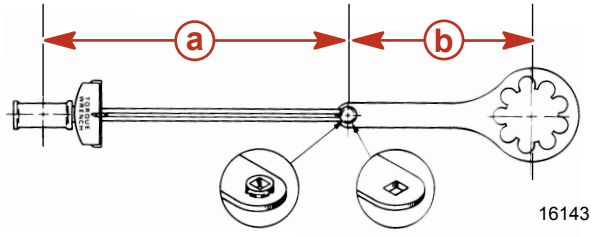
IMPORTANT: Ensure that the retainer nut is not cross-threaded by turning the retainer nut COUNTERCLOCKWISE until thread engagement is felt; then, turn retainer nut clockwise.

8. Install the U-joint retainer nut to driveshaft housing and torque.

15814

a - U-joint retainer nut
b - Bearing retainer wrench
c - Torque wrench

9. Use the specified torque chart and torque wrench as outlined in this section under **Torque Conversion Chart For U-joint Retainer Nut Tool**.



Typical Bravo retainer nut tool shown

a - Torque wrench length
b - U-joint retainer nut tool measurement, 30.5 cm (12 in.)

Bearing retainer wrench	91-17256

NOTE: *For Bravo X Series and Bravo XR, use the bearing retainer wrench tool to loosen and remove the retainer nut from the driveshaft housing.*

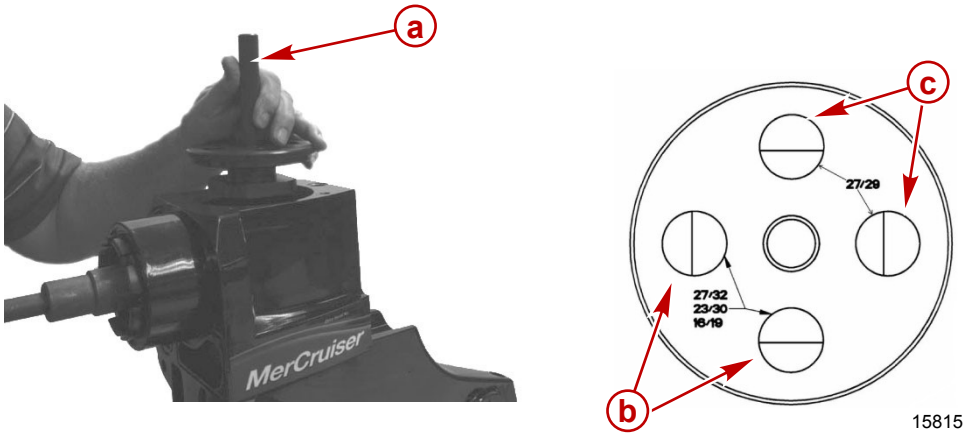
Spanner wrench for L-18 U-joint bearing retainer	91-862219A1

IMPORTANT: Ensure that the number of driven gear teeth match the drive gear ratio.

NOTE: *Diesel sterndrives are listed as Bravo X series.*

Driveshaft Housing— Gear Ratio and Gear Tooth Count			
Sterndrive model	**Ratio**	**Pinion (drive) gear teeth**	**Driven gear teeth**
Standard Bravo Three and Bravo Three X series	2.43:1	23	30
Standard Bravo Three and Bravo Three X series	2.20:1	23	30
Standard Bravo Two and Bravo Two X series			
Standard Bravo Three and Bravo Three X series	2.00:1	27	32
Standard Bravo Two and Bravo Two X series			
Standard Bravo Three and Bravo Three X series	1.81:1	27	29
Standard Bravo Two and Bravo Two X series			
Standard Bravo Three and Bravo Three X series	1.65:1	27	32
Standard Bravo Two and Bravo Two X series			
Standard Bravo One and Bravo One X series		23	30
Standard Bravo Three and Bravo Three X series	1.50:1	27	32
Standard Bravo One and Bravo One X series			
Standard Bravo Two and Bravo Two X series		27	29
Standard Bravo Three and Bravo Three X series	1.36:1	27	29
Standard Bravo One and Bravo One X series			
Bravo One XR	1.50:1	16	19
	1.35:1		
	1.26:1		
Bravo Three XR	2.00:1	27	32

10. Insert the pinion gear shimming tool in the top of the driveshaft housing. Position the matching gear teeth count access hole to the pinion gear.

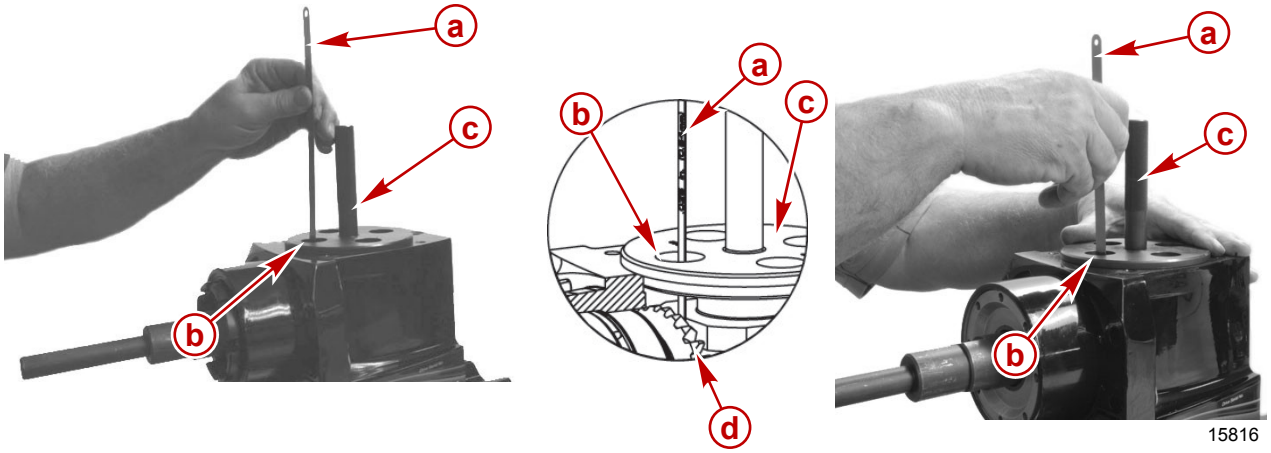


a - Pinion gear shimming tool
b - Access holes for gear tooth counts 27/32, 23/30, 16/19
c - Access holes for gear tooth counts 27/29

Pinion gear shimming tool	91-865114

NOTE: *Refer to* ***Feeler Gauge Measurement*** *for further assistance.*

11. Insert the feeler gauge and measure the clearance of the pinion gear shimming tool to the pinion gear teeth.



a - Feeler gauge
b - Access hole
c - Pinion gear shimming tool
d - Pinion gear

Specification	mm	in.
Pinion gear location	0.64	0.025

12. If the pinion gear location is within specification:
    a. Remove the pinion shimming tool from the driveshaft housing.
    b. Remove the the stub shaft tool complete assembly from the driveshaft housing.
    c. Proceed to **Measuring Driven Gear Lash** in this section.
13. If the pinion gear does not meet the specification:
    a. Calculate the difference of the existing pinion gear location measurement and the specified pinion gear measurement by using the shimming charts below.

For example, if the gear is too far away from shimming tool:

The shim assembled with the upper driven gear measures 0.89 mm (0.035 in.) thick and the existing pinion gear location measurement is 0.71 mm (0.028 in.).

NOTE: *Add shim thickness to move the pinion gear away from tool. Remove shim thickness to move the pinion gear closer to tool.*

The shim thickness should be decreased by 0.08 mm (0.003 in.).

Replace the shim with a 0.81 mm (0.032 in.) thick shim. Repeat the measurement process and check your work.

IMPORTANT: The shimming process must be repeated until the pinion gear location specifications are met.

Shimming Charts		
Description	**Shim thickness**	
Existing pinion gear location (feeler gauge thickness)	0.711 mm	(0.028 in.)
Specification	0.635 mm	(0.025 in.)
Remove shim measurement (difference)	0.076 mm	(0.003 in.)

For example, if the gear is too close to the shimming tool: The shim assembled with the upper driven gear measures 0.89 mm (0.035 in.) thick and the existing pinion gear location measurement is 0.56 mm (0.022 in.).

NOTE: *Add shim thickness to move pinion gear away from tool. Remove shim thickness to move pinion gear closer to tool.*

The shim thickness should be increased by 0.08 mm (0.003 in.).

Replace the shim with a 0.81 mm (0.032 in.) thick shim. Repeat the measurement process and check your work.

IMPORTANT: The shimming process must be repeated until the pinion gear location specifications are met.

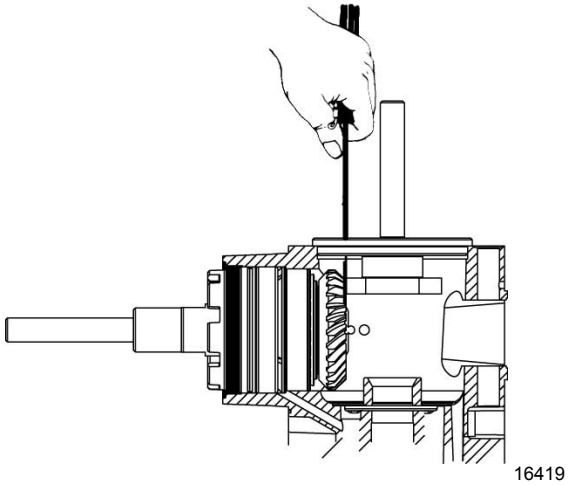
Shimming Charts		
Description	**Shim thickness**	
Specification	0.64 mm	(0.025 in.)
Existing pinion gear location (feeler gauge thickness)	0.56 mm	(0.022 in.)
Add shim measurement (difference)	0.08 mm	(0.003 in.)

NOTE: *A reference chart of the U-joint pinion gear shims follows:*

U-joint pinion gear shim	mm	in.
15-888927-028	0.71	0.028
15-888927-029	0.74	0.029
15-888927-030	0.76	0.030
15-888927-031	0.79	0.031
15-888927-032	0.81	0.032
15-888927-033	0.83	0.033
15-888927-034	0.86	0.034
15-888927-035	0.89	0.035
15-888927-036	0.91	0.036
15-888927-037	0.97	0.037
15-888927-038	0.97	0.038
15-888927-039	0.99	0.039
15-888927-040	1.02	0.040

FEELER GAUGE MEASUREMENT

1. To properly check gear location:
   a. Position the gear with at least 2 full teeth centered on the gauging surface. One full tooth must be on each side of the gauging surface center line. Insert a 0.64 mm (0.025 in.) feeler gauge between a tooth and the gauging surface.
   b. Slightly rotate the shimming tool until one side of the gauging surface contacts the feeler gauge and a slight drag is felt on the feeler gauge.
   c. Without moving the shimming tool, remove the feeler gauge and re-insert it between the other tooth and the gauging surface.

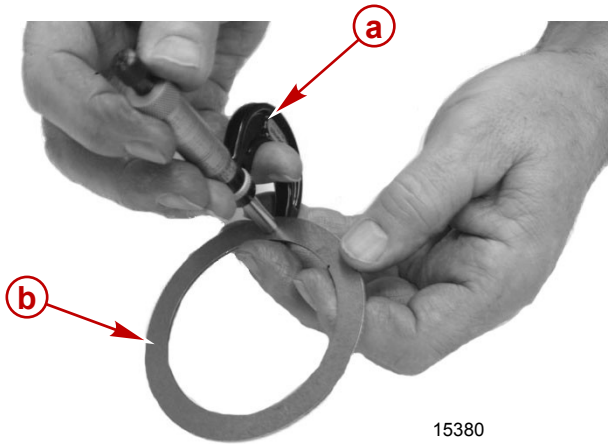

16419

2. **If the feeler gauge can be inserted with only a slight drag,** the shimming is correct.
3. **If the feeler gauge inserts with no drag,** repeat Steps 1., a., b., and c. with progressively thicker feeler gauges until the feeler gauge can be inserted with only a slight drag.
4. **If the feeler gauge cannot be inserted,** repeat Steps 1., a., b., and c. with progressively thinner feeler gauges until the feeler gauge can be inserted with only a slight drag.

Measuring Driven Gear Lash

IMPORTANT: Repeat the shimming process, Measuring Driven Gear Lash, until the gear lash measurement is within specifications.

1. Ensure that the U-joint pinion gear has completed the shimming procedure and is removed from the driveshaft housing.
2. Measure the upper and lower thrust race. Record this measurement.
3. If not using the original thrust race, use a thrust race with the specified thickness as a starting point or the same thickness as the original thrust race.



15380

a - Micrometer **b -** Thrust race

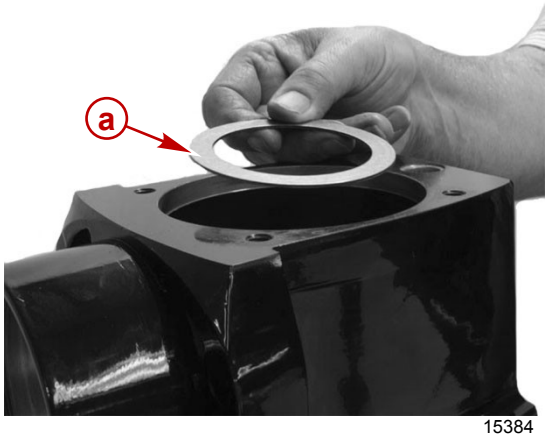
Starting thrust race specification	mm	in.
Driven gear thrust race	1.63	0.064

4. Lightly lubricate the lower thrust race.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Lower thrust race	92-802854A1

NOTE: *If using the original thrust race, race should be installed so that the side of original contact area is in the same position as removed.*

5. Position the lower thrust race in the center of the driveshaft housing.



15384

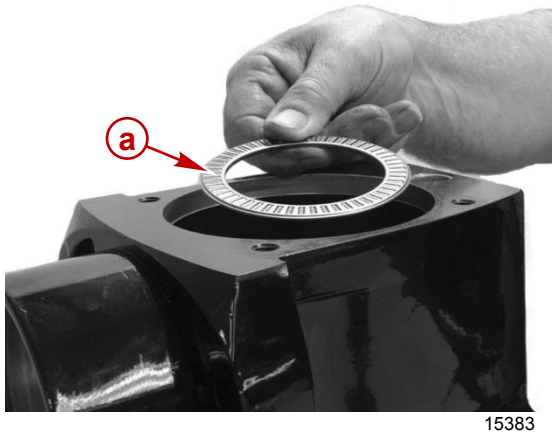
a - Lower thrust race

6. Lightly lubricate the lower thrust bearing.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Lower thrust bearing	92-802854A1

NOTE: *The thrust bearing is always positioned to the gear, and the thrust race (shim) is positioned to the driveshaft housing.*

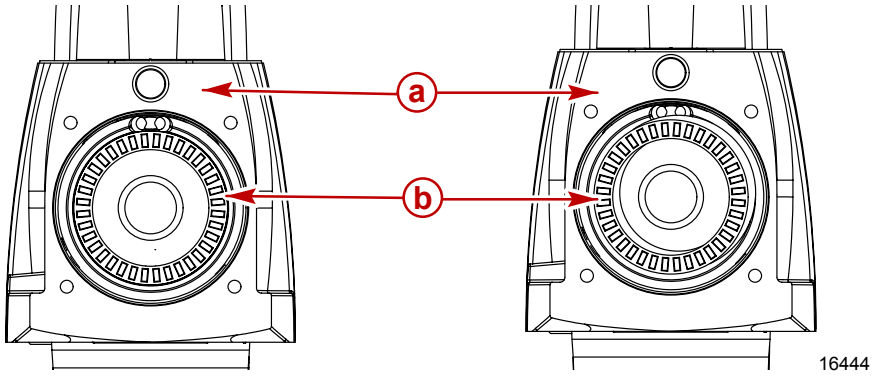
7. Position the lower thrust bearing on top of the lower thrust race in the center of the driveshaft housing.



15383

a - Lower thrust bearing

NOTE: *The clutch and gear assembly and the top cover assembly can not be properly installed if the lower thrust race and lower thrust bearing are positioned incorrectly.*



Positioned correctly **Positioned incorrectly**

a - Driveshaft housing **b -** Lower thrust bearing

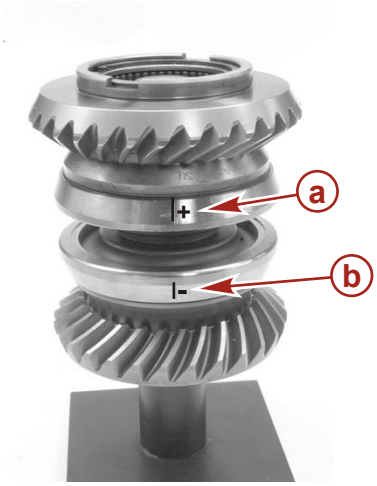
⚠ CAUTION

Mistiming of the clutch and gear assembly will cause the sterndrive not to shift out of gear properly and can cause damage and failure of the gear assembly. Always time the assembly as specified.

IMPORTANT: Do not align two positive (+) marks or two negative (–) marks.

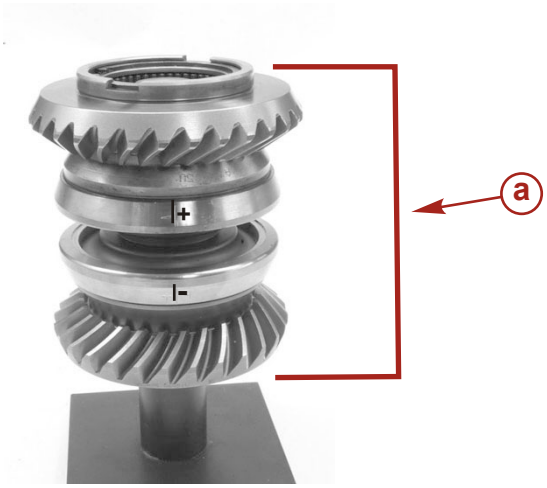
NOTE: *Timing marks on gears must be aligned in one of two ways. The positive (+) mark over the negative (–) or the negative (–) mark over the positive (+). Never align two positive (+) marks or two negative (–) marks.*

8. Position the clutch and gear assembly timing marks on gears.



a - Upper driven gear to the positive (+) mark **b -** Lower driven Gear to negative (–) mark

9. Lightly lubricate clutch and gear assembly.

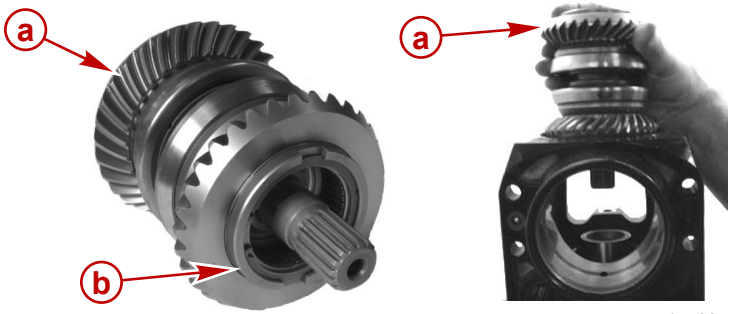


18179

a - Clutch and gear assembly

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Clutch and gear assembly	92-802854A1

10. Install the clutch and gear assembly into the driveshaft housing so that the timing marks on gears are easily visible through the back of the driveshaft housing.



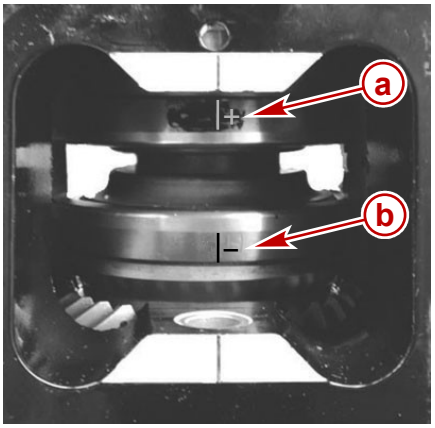
15793

a - Clutch and gear assembly

b - Bottom face of lower gear

11. Position the clutch and gear assembly timing marks on the gears.

NOTE: *The timing marks on the gears must be aligned in one of two ways. The positive (+) mark over the negative (–) or the negative (–) mark over the positive (+). Never align two positive (+) marks or two negative (–) marks.*

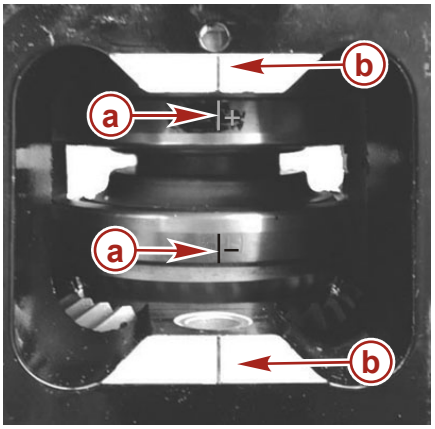


16557

Clutch and gear assembly properly installed in the driveshaft housing

a - Upper gear (+) positive timing mark **b -** Lower gear (–) negative timing mark

12. Align the timing index marks of the clutch and gear assembly with the index marks on driveshaft housing as close as possible.



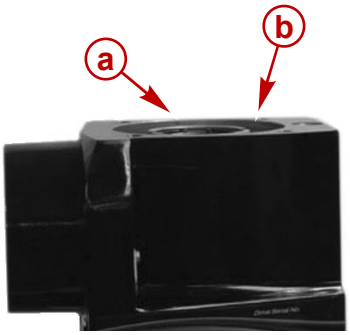
18180

Clutch and gear assembly properly installed in the driveshaft housing

a - Index marks on driven gears **b -** Index marks on driveshaft housing

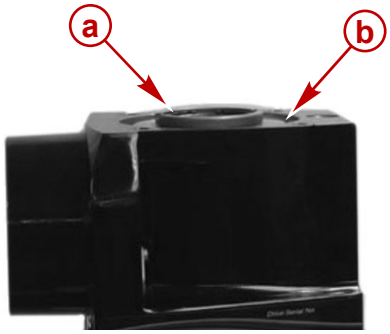
13. Ensure that the clutch and gear assembly is positioned below the top of the driveshaft housing.

14. If the clutch and gear assembly is above the driveshaft housing, reposition the lower thrust race and lower thrust bearing.



15794

Positioned correctly



15795

Positioned incorrectly

a - Clutch and gear assembly

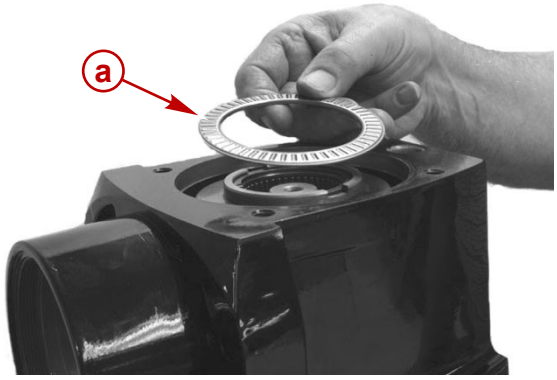
b - Driveshaft housing

15. Lightly lubricate thrust bearing.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Thrust bearing	92-802854A1

NOTE: *The thrust bearing is always aligned to the gear, and the thrust race (shim) is aligned to the driveshaft housing.*

16. Position the upper thrust bearing on top of the clutch and gear assembly.



15381

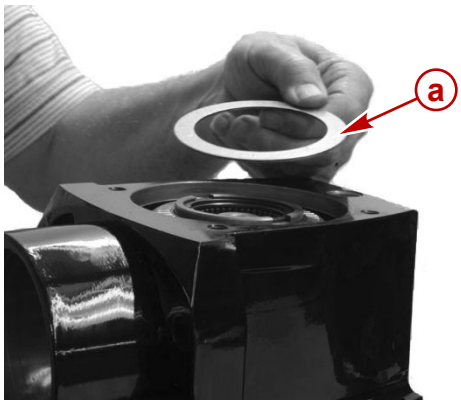
a - Thrust bearing

17. Lightly lubricate the thrust race.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Thrust race	92-802854A1

NOTE: *If using the original thrust race, install the race so the side of original contact area is in the same position as the one removed.*

18. Position the upper thrust race on top of upper thrust bearing.

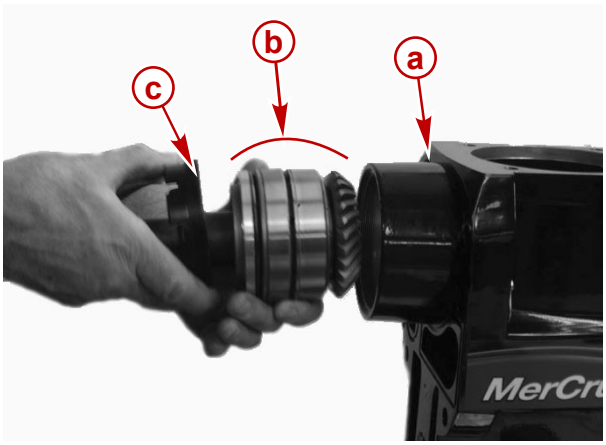


15379

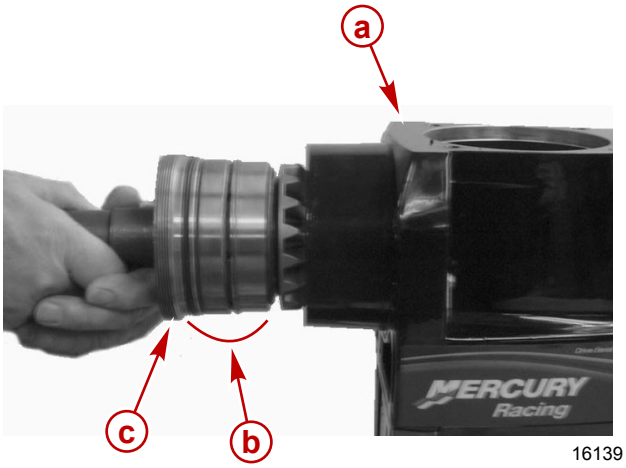
a - Thrust race

NOTE: *Ensure that the shim is positioned on the shoulder of the flanged bearing cup .*

19. Carefully install the stub shaft tool complete assembly into the driveshaft housing bore so not to damage the shim.



15813



16139

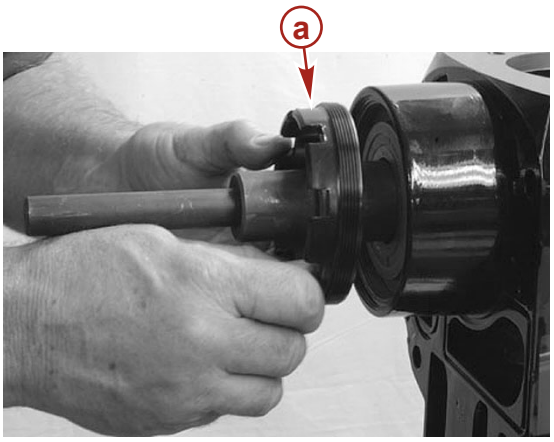
a - Driveshaft housing
b - Stub Shaft tool complete assembly
c - Retainer nut

20. Apply lubricant to the threads of the retaining nut.

Tube Ref No.	Description	Where Used	Part No.
34	Special Lubricant 101	Threads of retainer nut	92-802865A1

IMPORTANT: Ensure that the retainer nut is not cross-threaded by turning the retainer nut COUNTERCLOCKWISE until you feel the threads engage and then turn the retainer nut clockwise.

21. Install the U-joint retainer nut to driveshaft housing.

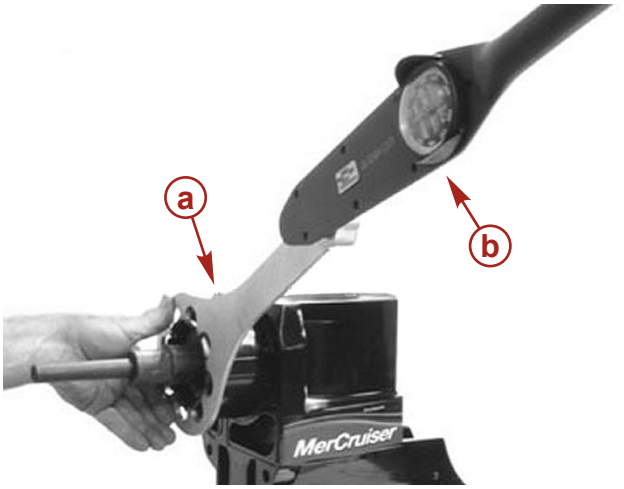


18183

Standard Bravo shown

a - U-joint retainer nut

22. Torque the retainer nut.

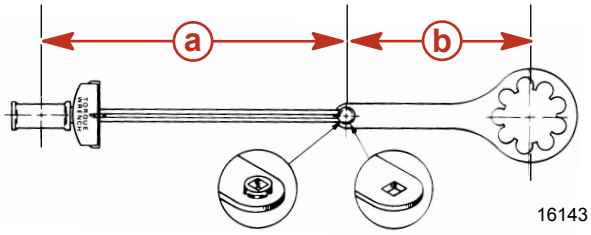


18182

Standard Bravo shown

a - Bearing retainer wrench tool **b -** Torque wrench

23. Use the specified torque chart and torque wrench as outlined in this section under **Torque Conversion Chart For U-joint Retainer Nut Tool**.



16143

Typical Bravo retainer nut tool shown

a - Torque wrench length **b -** U-joint retainer nut tool measurement, 30.5 cm (12 in.)

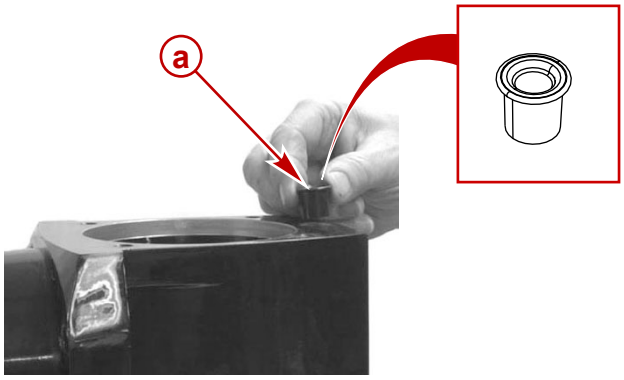
Bearing retainer wrench	91-17256

NOTE: *For Bravo XZ, XR and Diesel Bravo drives use the bearing retainer wrench for Bravo X series tool to loosen and remove the retainer nut from the driveshaft housing.*

Spanner wrench for L-18 U-joint bearing retainer	91-862219A1

NOTE: *The shift shaft upper seal must be installed on the driveshaft housing before you can install the top cover.*

25. Insert the shift shaft seal into the driveshaft housing.

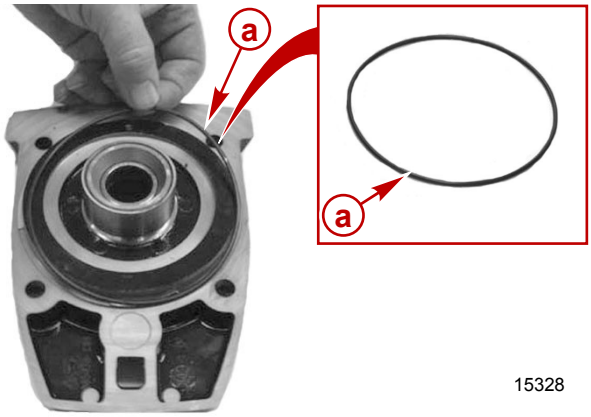


15330

a - Shift shaft seal

NOTE: *Ensure that the top cover O-ring is positioned correctly.*

26. Apply lubricant to the top cover O-ring and install to the top cover.

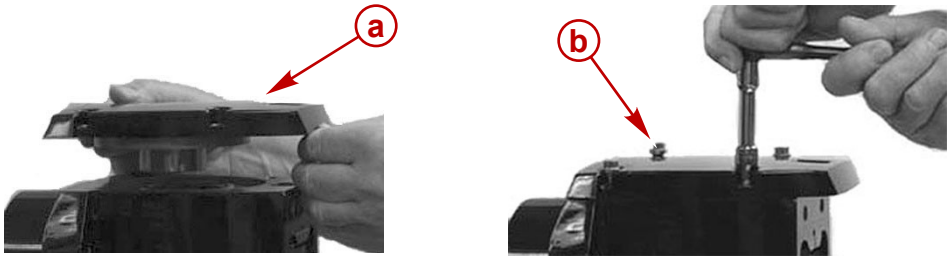


15328

a - Top cover O-ring

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Top cover O-ring	92-802854A1

27. Install the top cover and torque the screws.



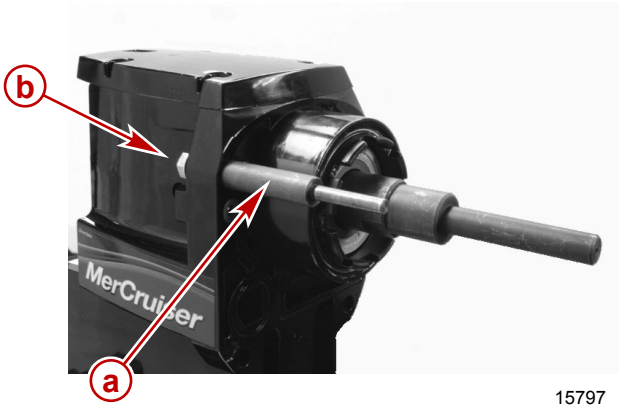
16430

a - Top cover

b - Bolts

Description	Nm	lb. in.	lb. ft.
Driveshaft housing top cover screws	27		20

28. Install the adapter rod tool in the top stud hole of the driveshaft housing and tighten the nut.

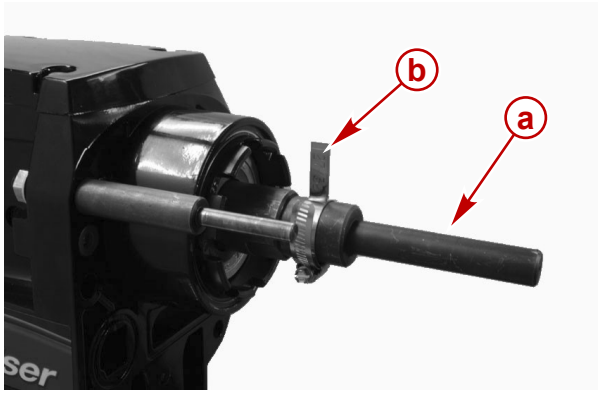


15797

a - Adapter rod tool **b -** Nut

Adaptor rod tool	91- 865086

29. Install the gear lash flag onto the stub shaft tool. Ensure that the drive tooth count matches the numbers on the flag.
30. Align the indicator mark of the gear lash flag toward the stub shaft tool.

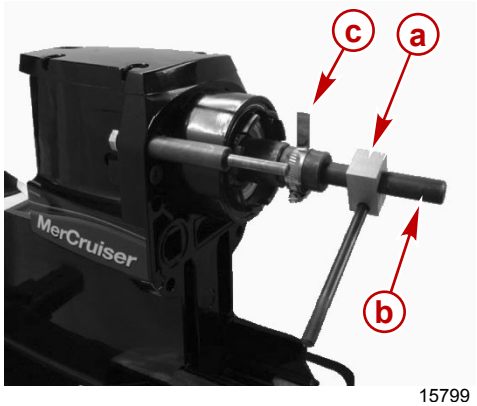


15798

a - Stub shaft tool **b -** Gear lash flag

Gear lash flag 27/32	91-865080
Gear lash flag 27/29	91-865081
Gear lash flag 23/30	91-865082
Gear lash flag 16/19	91-865116

31. Install the clamp block and handle tool on the end of the stub shaft tool. Tighten just to snug up to shaft.

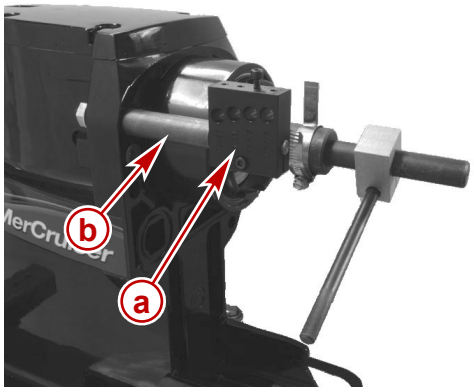


15799

a - Clamp block and handle tool
b - Stub shaft tool
c - Gear lash flag

Clamp block and handle tool	91-865085

32. Install the dial indicator holding block to the adapter rod and nut tool.



15800

a - Dial indicator holding block
b - Adapter rod and nut tool

Dial indicator holding block	91-865097

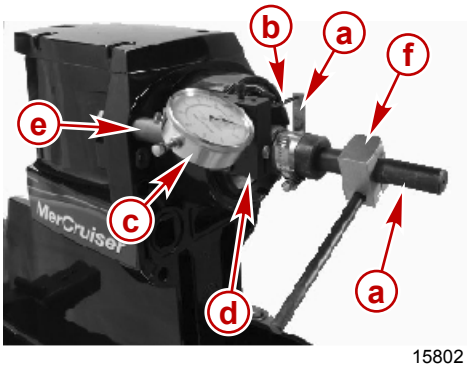
NOTE: *Use the short extension tip for the dial indicator.*

33. Install the dial indicator to the holding block using the correct drive gear ratio access hole.

Dial indicator	91-58222A1

34. Position the dial indicator holding block to align the dial indicator tip 90° parallel to the gear lash flag indicator mark.

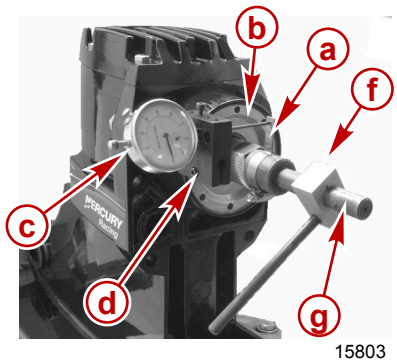
35. Final alignment can be made to ensure that the gear lash flag is positioned vertically on the stub shaft tool.



15802

Standard Bravo

- **a -** Gear lash flag
- **b -** Dial indicator tip
- **c -** Dial indicator
- **d -** Dial indicator holding block

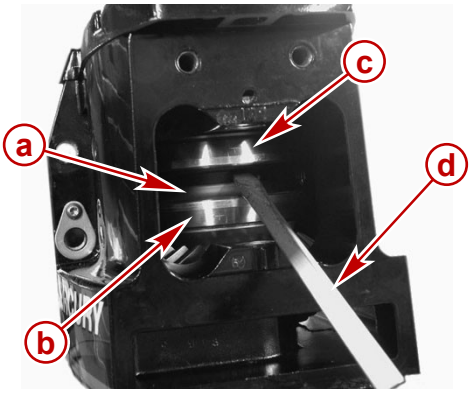


15803

Bravo X Series

- **e -** Adapter rod tool
- **f -** Clamp block and handle tool
- **g -** Stub shaft tool

36. Reposition the clutch for the clamp tool installation by carefully pushing the clutch up with a screwdriver to gain access to the upper driven gear.



15804

- **a -** Clutch
- **b -** Lower driven gear torus ring
- **c -** Upper driven gear torus ring
- **d -** Screwdriver

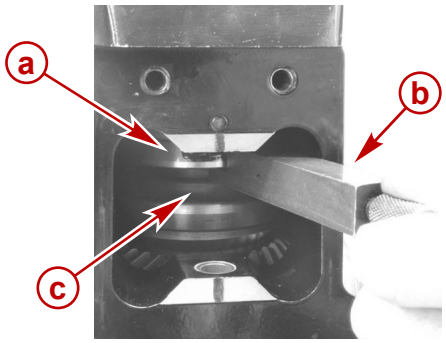
NOTE: *The clutch and gear assembly timing marks "+" and "–" must remain aligned while measuring gearlash.*

NOTE: *The driven gear clamping tool clamps to the torus ring.*

16440

- **a -** Driven gear torus ring
- **b -** Driven gear clamping tool

37. Install the driven gear clamping tool to the upper driven gear of the clutch and gear assembly. Position the tool so you can hold the clamping tool while reading the dial indicator.

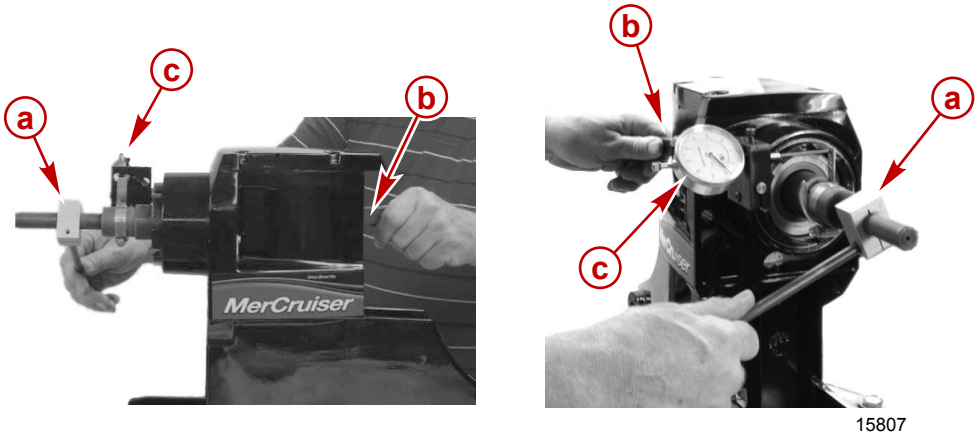


15805

a - Upper driven gear torus ring
b - Driven gear clamping tool
c - Clutch

Driven gear clamping tool	91-865115

38. Make final adjustments enabling holding the driven gear clamping tool with one hand and the handle tool with the other hand while reading the dial indicator. Tighten the clamp block and handle tool to the stub shaft tool.
39. Hold the driven gear in locked position with the driven gear clamping tool. Slightly rotate the clamp block and handle tool back and forth to move the U-joint pinion gear, to feel the gear lash.

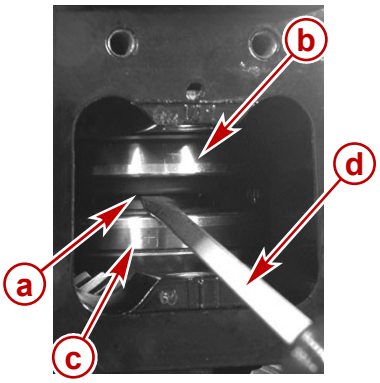


15807

a - Clamp block and handle tool
b - Driven gear clamping tool
c - Dial indicator

40. Observe the dial gauge while rotating the pinion gear back and forth to feel the gear lash. Record this measurement as an **upper** driven gear measurement.
41. Remove the driven gear clamping tool from the upper driven gear.

42. Reposition the clutch, carefully pushing the clutch down with a screwdriver to gain access to the lower driven gear.

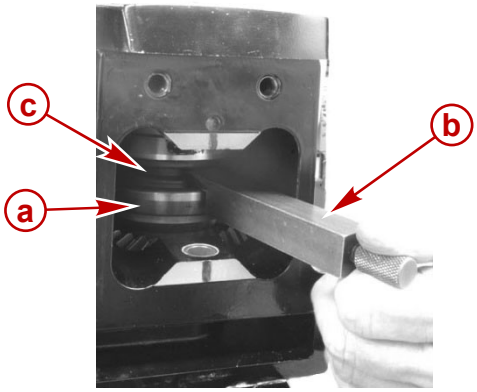


15806

a - Clutch
b - Upper driven gear
c - Lower driven gear
d - Screwdriver

43. Install the driven gear clamping tool to the lower driven gear of the clutch and gear assembly.

NOTE: *The driven gear clamping tool clamps to the lower torus ring.*

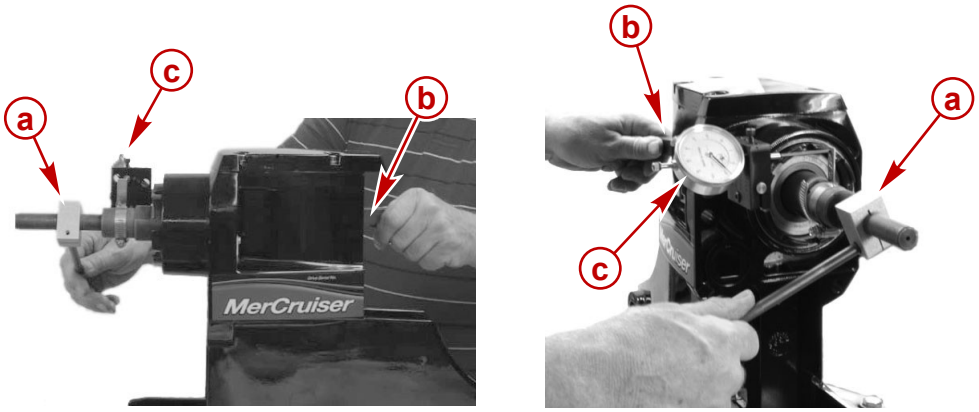


15817

a - Lower gear torus ring
b - Driven gear clamping tool
c - Clutch

Driven gear clamping tool	91-865115

44. Hold the driven gear in locked position with the driven gear clamping tool. Slightly rotate the clamp block and handle tool back and forth to move the U-joint pinion gear, to feel the gear lash.



15807

a - Clamp block and handle tool
b - Driven gear clamping tool
c - Dial indicator

45. Observe the dial gauge while rotating the pinion gear back and forth to feel the gear lash. Record measurement as a lower driven gear measurement.

NOTE: *The upper driven gear and lower driven gear have the same gear lash specification.*

Drive gear tooth	Driven gear tooth	Gear lash specification
27	32	0.279 mm–0.406 mm [(0.011 in.)–(0.016 in.)]
27	29	0.330 mm–0.457 mm [(0.013 in.)–(0.018 in.)]
23	30	0.279 mm–0.406 mm [(0.011 in.)–(0.016 in.)]
16	19	0.229 mm–0.381 mm [(0.009 in.)–(0.015 in.)]

46. If the gear lash measurement of the **upper** driven gear and the **lower** driven gear are within specification:
    a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover from the driveshaft housing.
    b. Remove all components from the stub shaft tool.
    c. The upper thrust race and upper thrust bearing, clutch and gear assembly, and the lower thrust bearing and lower thrust race remain in the driveshaft housing for complete reassembly of the driveshaft housing.
    d. Proceed to **Drive Reassembly**.

NOTE: *Refer to* ***Calculation Method For Specified Gear Lash*** *in this section.*

47. If the gear lash measurement of the **upper** driven gear is incorrect and the **lower** driven gear is within the specified measurement:
    a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover and the upper thrust race from the driveshaft housing.
    b. Replace only the **upper** thrust race.
    c. Repeat the measurement process.
48. If the gear lash measurement of the **lower** driven gear is incorrect and the **upper** driven gear is within the specified measurement:
    a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover, upper thrust race and upper thrust bearing, clutch and gear assembly, and the lower thrust bearing and lower thrust race from the driveshaft housing.

b. Replace only the **lower** thrust race.

c. Repeat the measurement process.

49. If the gear lash measurement of the **upper** driven gear and the **lower** driven gear are incorrect:

a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover, upper thrust race and thrust bearing, clutch and gear assembly, and the lower thrust bearing and thrust race from the driveshaft housing.

b. Replace the **upper** thrust race and the **lower** thrust race.

c. Repeat the measurement process.

IMPORTANT: The shimming process must be repeated until gear lash is within specifications.

CALCULATION METHOD FOR SPECIFIED GEAR LASH

⚠ CAUTION

Using multiple thrust races to obtain the specified gear lash can cause drive damage and failure. Always use the correct race.

1. **If the gear lash is not within specification:**

a. Calculate the difference of the existing gear lash measurement and the specified gear lash measurement by using the gear lash charts below.

b. Make the gear lash measurement changes by removing or adding thrust race thickness.

For example, if the gear lash measurement is too high:

The thrust race assembled with the driven gear measures 1.55 mm (0.061 in.) thick and the gear lash measurement is 0.43 mm (0.017 in.).

NOTE: *Use the midpoint of the specified gear lash. If the specified gear lash is 0.28–0.41 mm (0.011–0.016 in.), use the midpoint of 0.36 mm (0.014 in.).*

The thrust race thickness should be **increased** by 0.08 mm (0.003 in.).

Replace the thrust race with a 1.63 mm (0.064 in.) thick thrust race. Repeat the measurement process and check your work.

Gear lash chart		
Description	**Thrust race thickness**	
Existing gear lash measurement	0.432 mm	(0.017 in.)
Specification	0.356 mm	(0.014 in.)
Add thrust race measurement (difference)	**0.076 mm**	**(0.003 in.)**

For example, If the gear lash measurement is too low:

The thrust race assembled with the driven gear measures 1.55 mm (0.061 in.) thick and the gear lash measurement is 0.30 mm (0.012 in.).

NOTE: *NOTE: Use the midpoint of the specified gear lash; if the specified gear lash is 0.28–0.41 mm (0.011–0.016 in.), use the mid point of 0.36 mm (0.014 in.).*

The thrust race thickness should be **decreased** by 0.05 mm (0.002 in.).

Replace the thrust race with a 1.50 mm (0.059 in.) thick thrust race. Repeat the measurement process and check your work.

Gear lash chart		
Description	**Thrust race thickness**	
Specification	0.356 mm	(0.014 in.)
Existing gear lash measurement	0.305 mm	(0.012 in.)
Remove thrust race measurement (difference)	**0.051 mm**	**(0.002 in.)**

Adding thrust race thickness positions the driven gear closer to the pinion gear, **reducing** gear lash.

Removing thrust race thickness positions the driven gear farther away from the pinion gear, **increasing** gear lash.

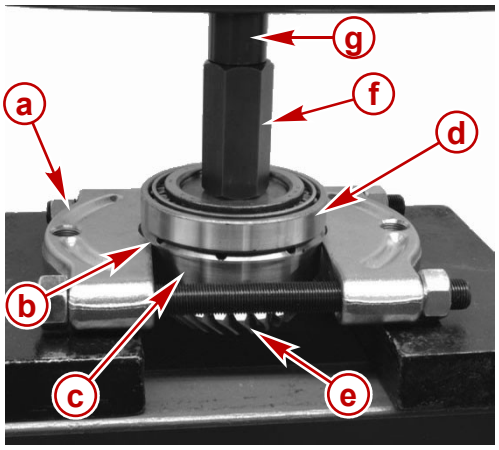
Thrust bearing race	Thickness	Color code
23-864596-058	1.47 mm (0.058 in.)	Brown
23-864596-059	1.50 mm (0.059 in.)	White
23-864596-060	1.52 mm (0.060 in.)	Orange
23-864596-061	1.55 mm (0.061 in.)	Green
23-864596-062	1.57 mm (0.062 in.)	Yellow
23-864596-063	1.60 mm (0.063 in.)	Red
23-864596-064	1.63 mm (0.064 in.)	Light Blue
23-864596-065	1.65 mm (0.065 in.)	Black
23-864596-066	1.68 mm (0.066 in.)	Pink
23-864596-067	1.70 mm (0.067 in.)	Purple

Driveshaft Housing Reassembly

Reset U-joint Pinion Gear and Bearing Preload

IMPORTANT: Reset the U-joint pinion gear and bearing assembly preload after the shimming procedure and before it is reinstalled into the driveshaft housing.

1. Carefully remove the shim from the pinion gear and bearing assembly.
2. Release the pinion gear and bearing assembly preload:
   a. Place the universal puller plate tool under the shoulder of the flanged bearing cup.
   b. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure.



16412

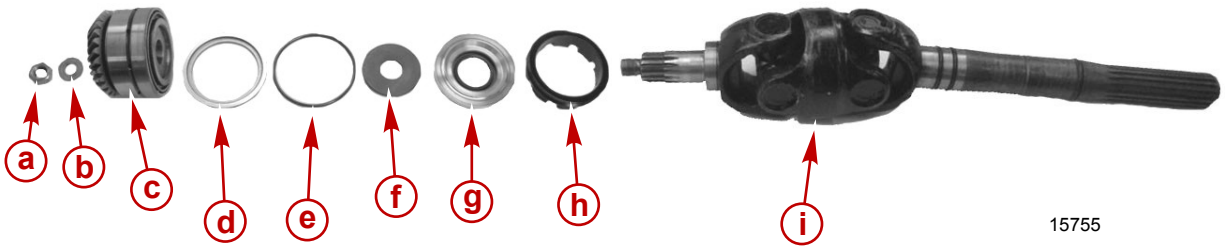
a - Universal puller plate tool
b - Flanged bearing cup shoulder
c - Flanged bearing cup
d - Top roller bearing and bearing cup
e - Pinion gear
f - Mandrel on pinion gear
g - Press on mandrel

Universal puller plate	91-37241

U-joint, Pinion Gear and Bearing Assembly Reassembly

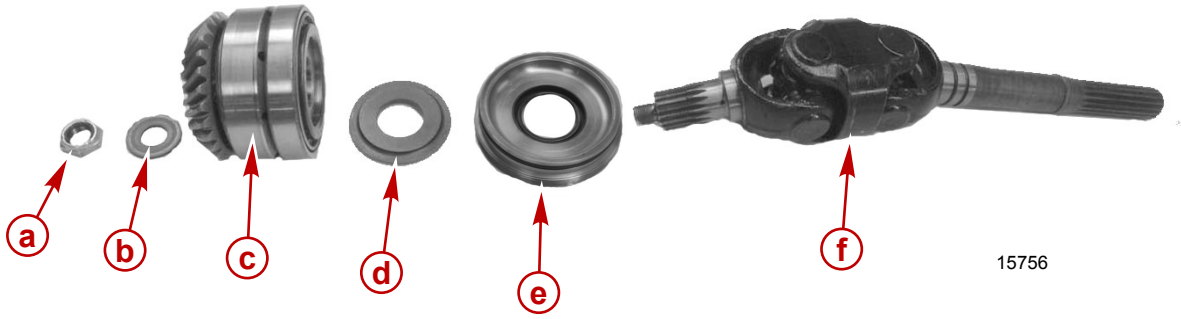
⚠ CAUTION

Improper reassembly of the U-joint and pinion gear assembly can cause damage or failure of the sterndrive. Reassemble the U-joint and pinion gear as specified.



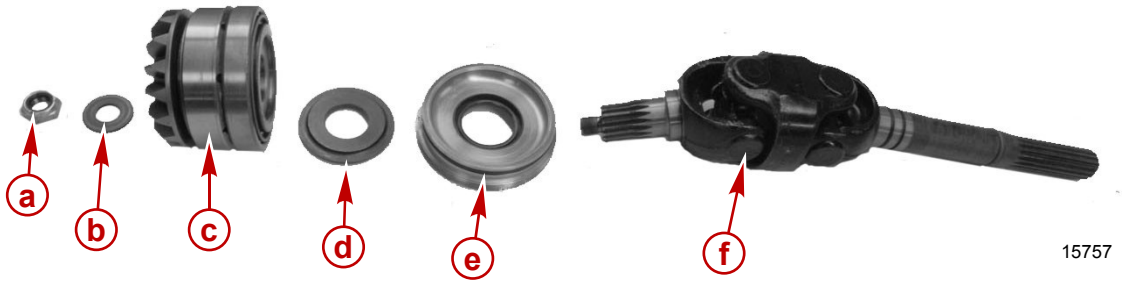
Standard Bravo U-joint assembly

- **a -** Pinion nut
- **b -** Washer
- **c -** Pinion gear and bearing assembly
- **d -** Sealing ring
- **e -** O-ring
- **f -** Thrust washer
- **g -** Oil seal and oil seal carrier
- **h -** Retainer nut
- **i -** U-joint



Bravo X series U-joint assembly

- **a -** Pinion nut
- **b -** Washer
- **c -** Pinion gear and bearing assembly
- **d -** Thrust washer
- **e -** O-ring, oil seal, oil seal carrier, and retainer nut
- **f -** U-joint



Bravo XR U-joint assembly

- **a -** Pinion nut
- **b -** Washer
- **c -** Pinion gear and bearing assembly
- **d -** Thrust washer
- **e -** O-ring, oil seal, oil seal carrier, and retainer nut
- **f -** U-joint

The stacking procedure below can be followed for the assembly of all Bravo U-joint assemblies. However, the Bravo X series and the Bravo XR models must refer to specified U-joint exploded view for the parts order and orientation of U-joint reassembly.

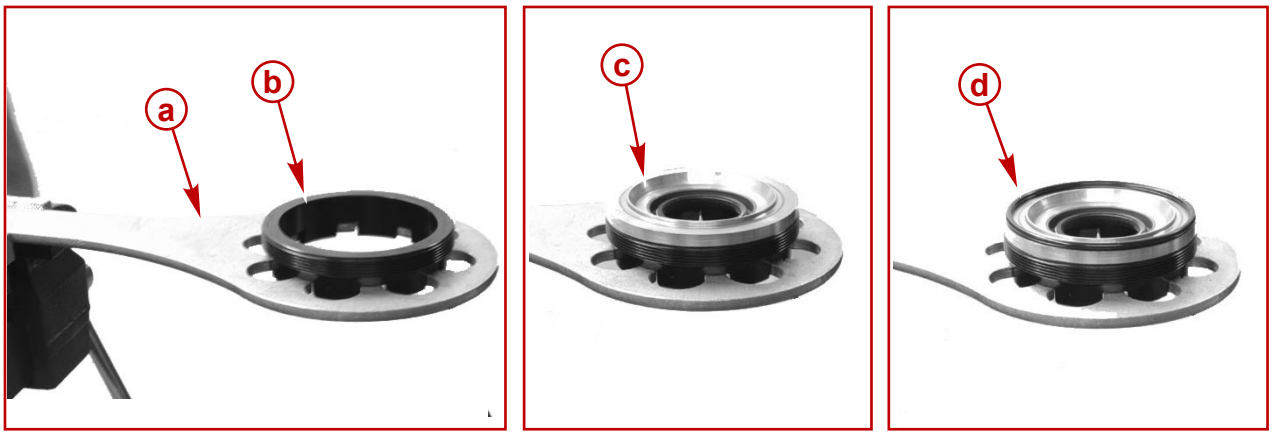
1. Stacking procedure for reassembling a Standard Bravo U-joint, pinion gear and bearing assembly.

NOTE: *Bravo X series and the Bravo XR models must refer to specified U-joint exploded view for the parts order and orientation of U-joint reassembly.*

a. Place bearing retainer wrench tool in a vise and add the retainer nut.

b. Stack the oil seal and oil seal carrier on the retainer nut.

c. Install the O-ring to oil seal carrier.



16399

Standard Bravo model shown Bravo X series and Bravo XR models are similar.

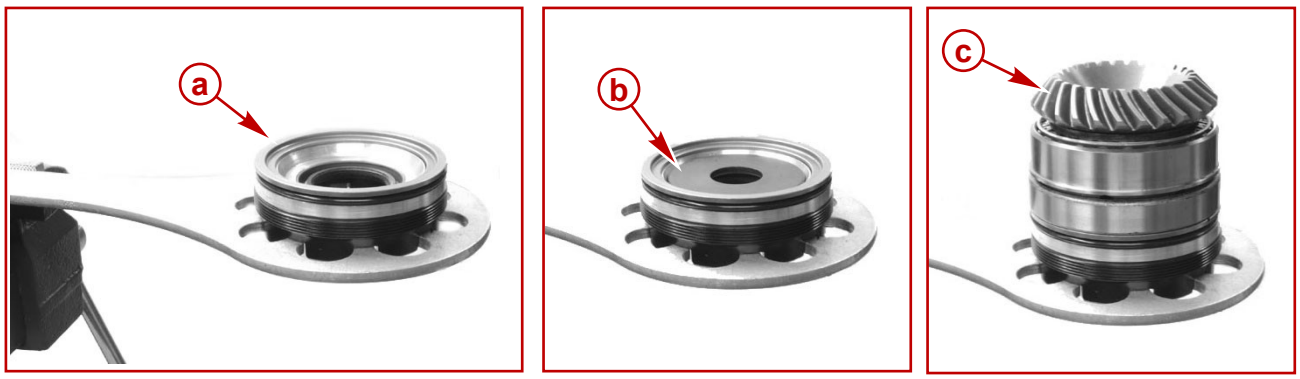
a - Bearing retainer wrench tool
b - Retainer nut
c - Oil seal and oil seal carrier
d - O-ring

Bearing retainer wrench	91-17256

d. Stack the sealing ring on the oil seal carrier.

e. Place the thrust washer, flat side up, on the oil seal carrier.

f. Stack the pinion gear and bearing assembly on the thrust washer and sealing ring.



16400

Standard Bravo model shown Bravo X series and Bravo XR models are similar.

a - Sealing ring
b - Thrust washer
c - Pinion gear and bearing assembly

g. Apply lubricant to the washer and threads of retainer nut.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	U-joint pinion gear washer and retainer nut	92-802854A1

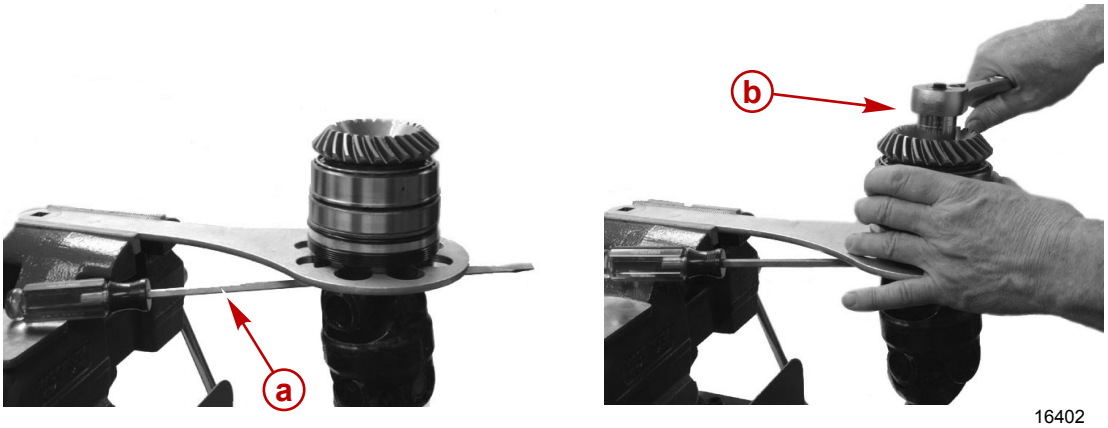
h. Install the U-joint from the bottom of the stacked assembly.

i. Place the washer over the U-joint stub and hand-start the pinion nut.

a - U-joint
b - Washer
c - Pinion nut

j. Use a screwdriver to secure the U-joint.

k. Tighten the pinion nut until the washer contacts the gear. Do not overtighten the nut before setting the preload.



a - Screwdriver
b - Ratchet and socket

NOTE: *Complete the U-joint and pinion gear preload procedure before installing the assembly to the driveshaft housing.*

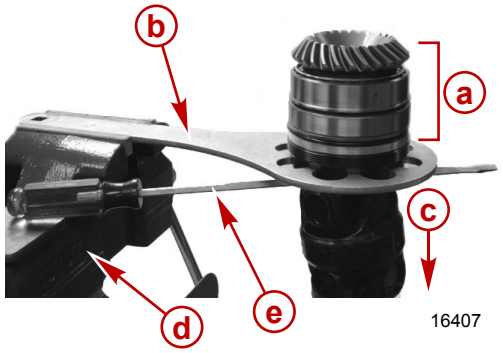
U-joint Pinion Gear and Bearing Assembly Preload

Follow only one of the procedures: **Setting Preload Using a Vise, Setting Preload In The Driveshaft Housing.**

SETTING PRELOAD USING A VISE

1. Set the preload on bearing package as follows:
   a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly.

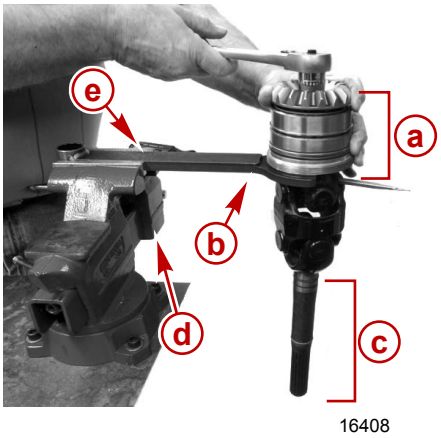
b. Position the U-joint assembly with its shaft facing down as shown.



Standard Bravo

a - U-joint pinion gear and bearing assembly
b - Bearing retainer wrench
c - U-joint shaft (facing down)
d - Vise
e - Screwdriver

Bearing retainer wrench	91-17256



Bravo X series

a - U-joint pinion gear and bearing assembly
b - Bearing retainer wrench
c - U-joint shaft (facing down)
d - Vise
e - Screwdriver

Spanner wrench for L-18 U-joint bearing retainer	91-862219A1

c. Apply a light coat of lubricant to bearings.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bearings	92-802854A1

d. Set preload by tightening the nut 1/16 of a turn at a time.

e. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and a dial torque wrench lb. in. until you reach the specified torque.

⚠ CAUTION

Avoid premature bearing failure. Do not overtighten the U-joint pinion gear nut.

16409

Standard Bravo shown Bravo X series similar

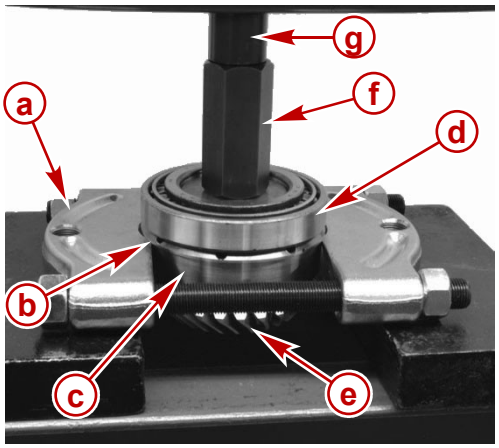
a - Dial type torque wrench (lb. in.)

NOTE: *Bearings are used if spun once under load.*

Description	New	Used
U-joint bearing preload	0.7–1.0 Nm (6–10 lb. in.)	0.3–0.8 Nm (3–7 lb. in.)

Torque wrench, lb. in.	91-66274

2. **If the nut becomes overtightened (causing excessive preload),** release the pinion gear and bearing assembly preload.
   a. Remove the pinion gear and the bearing assembly from the U-joint.
   b. Place the universal puller plate under the shoulder of the flanged bearing cup.
   c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure.



16412

a - Universal puller plate tool
b - Flanged bearing cup shoulder
c - Flanged bearing cup
d - Top roller bearing and bearing cup
e - Pinion gear
f - Mandrel on pinion gear
g - Press on mandrel

Universal puller plate	91-37241

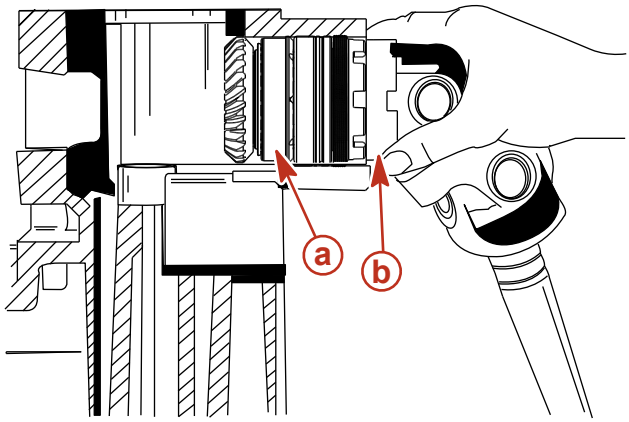
   d. Reassemble the components of the U-joint and repeat the preload procedures.

SETTING PRELOAD IN THE DRIVESHAFT HOUSING

1. Set the preload on a U-joint pinion gear-and-bearing assembly as follows:
   a. Apply a light coat of lubricant to bearings.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Bearings	92-802854A1

   b. Install the U-joint and pinion gear assembly into the driveshaft housing.



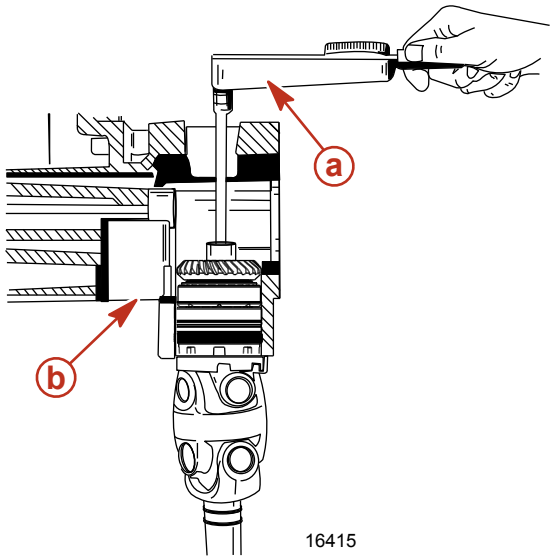
Standard Bravo shown Bravo X series similar

a - U-joint and pinion gear assembly **b -** Retaining nut

   c. Position the driveshaft housing so that the U-joint coupling shaft is pointing straight down.
   d. Set the preload by tightening the nut 1/16 of a turn at a time. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and dial torque wrench until you reach an acceptable torque.

⚠ CAUTION

Premature bearing failure can result if U-joint pinion gear nut becomes overtightened (causing excessive preload).



Standard Bravo shown Bravo X series similar

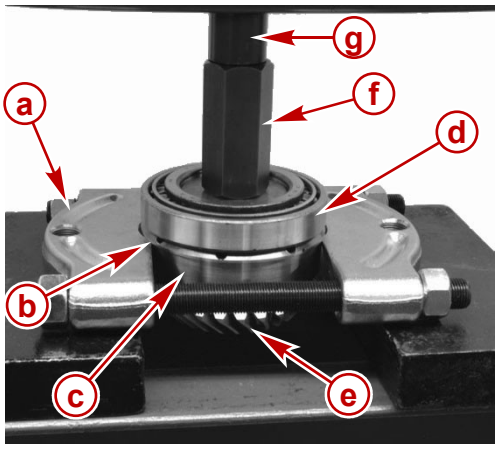
a - Dial torque wrench (lb. in.) **b -** Driveshaft housing (U-joint shaft facing down)

NOTE: *Bearings are used if spun once under load*

Description	New	Used
U-joint bearing preload	0.7–1.0 Nm (6–10 lb. in.)	0.3–0.8 Nm (3–7 lb. in.)

Torque wrench, lb. in.	91-66274

2. Remove U-joint and pinion gear assembly from driveshaft housing.
3. **If nut becomes overtightened (causing excessive preload)**, release the pinion gear and bearing assembly preload:
   a. Remove the pinion gear and bearing assembly from the U-joint.
   b. Place the universal puller plate under the shoulder of the flanged bearing cup.
   c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure.



16412

a - Universal puller plate tool
b - Flanged bearing cup shoulder
c - Flanged bearing cup
d - Top roller bearing and bearing cup
e - Pinion gear
f - Mandrel on pinion gear
g - Press on mandrel

Universal puller plate	91-37241

   d. Reassemble components to the U-joint and repeat preload procedures.

Bravo Drive Unit Service

Section 8D - Bravo One Gear Housing Setup

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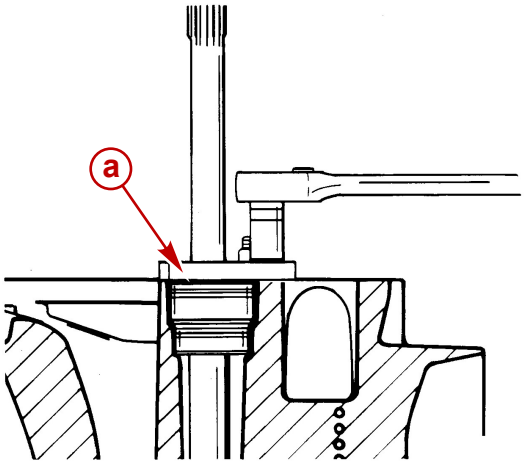
Pinion Gear Location Shimming/Setup Procedure 5
Driven Gear Lash Shimming/Setup Procedure.....6
Checking/Adjusting Final Propeller Shaft and Overall Gear Housing Bearing Preload (Rolling Torque).....9
Major Differences Between The Bravo One And Bravo Two Gear Housing.....11

8
D

Driveshaft Bearing Preload Shimming/Setup Procedure

1. Remove clamp plate.

NOTE: *Clamp plate was installed after drive shaft housing and gear housing were split.*

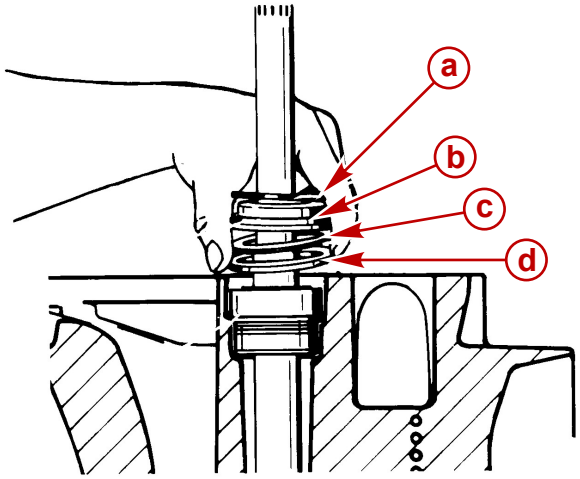


20288

a - Clamp plate

2. Remove O-ring, spacer, and shims.

NOTE: *There should not be any shims between the tab washer and the bearing.*

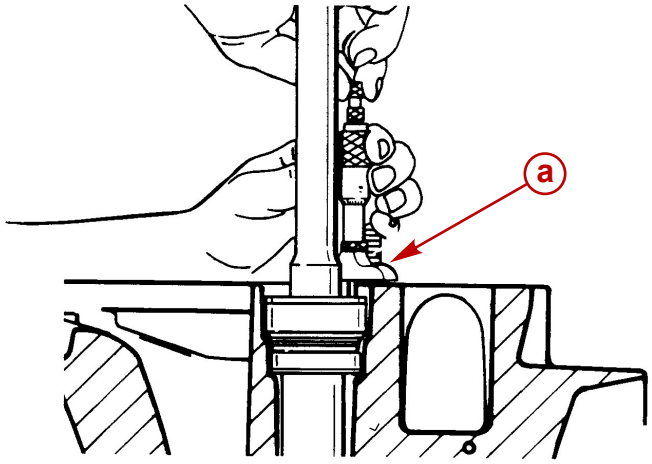


20290

a - O-ring
b - Spacer
c - Shims
d - Tab washer (above bearing)

3. Determine shim thickness required for drive shaft bearing preload.

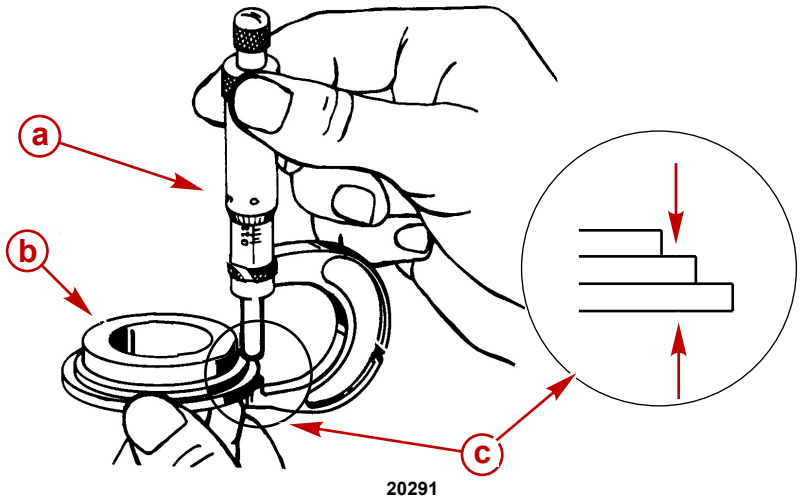
a. Measure distance between top of gear housing and tab washer, at three locations.



19835

a - 0-to-1 in. Depth Micrometer

b. Measure thickness of spacer from top machined surface to bottom machined surface.



20291

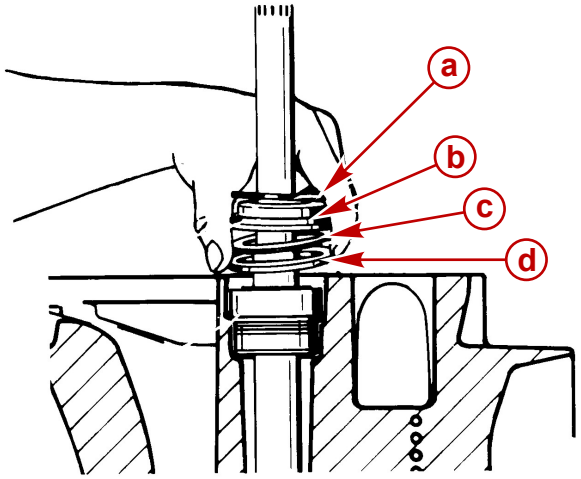
a - Outside Micrometer
b - Spacer
c - Location of measurement

c. Calculate shim thickness as shown:

Measurement found in Step "a"
minus measurement found in Step "b"
+ .001 in. = Shim thickness required.

(a – b) + .001 = Shim(s) required

4. Install calculated amount of shims, spacer, and new O-ring.



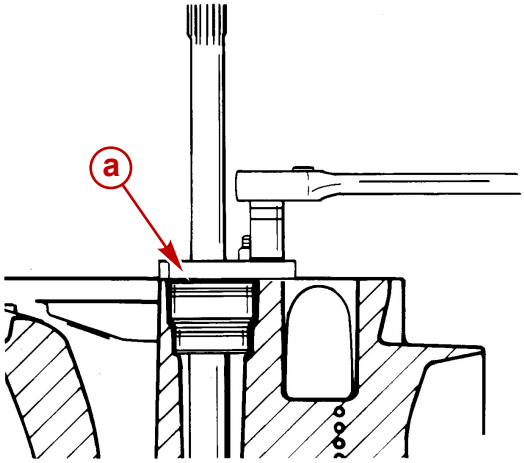
20290

a - New O-ring
b - Spacer
c - Shims
d - Tab washer (above bearing)

5. Reinstall clamp plate on gear housing.
6. Tighten nuts to specification.

Description	Nm	lb. in.	lb. ft.
Clamp plate nuts	47.5		35

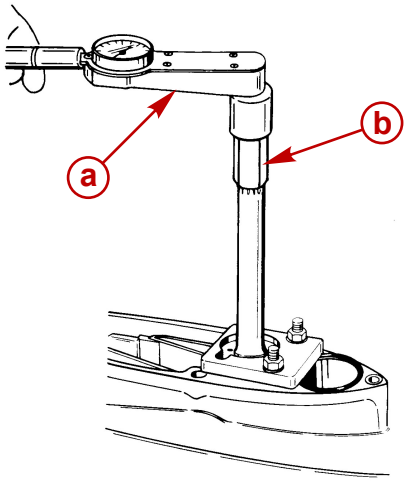
NOTE: *Use two washers on each stud (under nuts) so that nut does not run out of threads when torquing it down.*



20288

a - Clamp plate

7. Using a dial-type (lb. in.) torque wrench, check the rolling preload -0.3-0.6 Nm (3-5 lb. in.). Adjust preload, as necessary, to attain proper reading. Add shims to increase rolling torque. Subtract shims to decrease rolling torque. After correct rolling torque is achieved, then check pinion gear location.



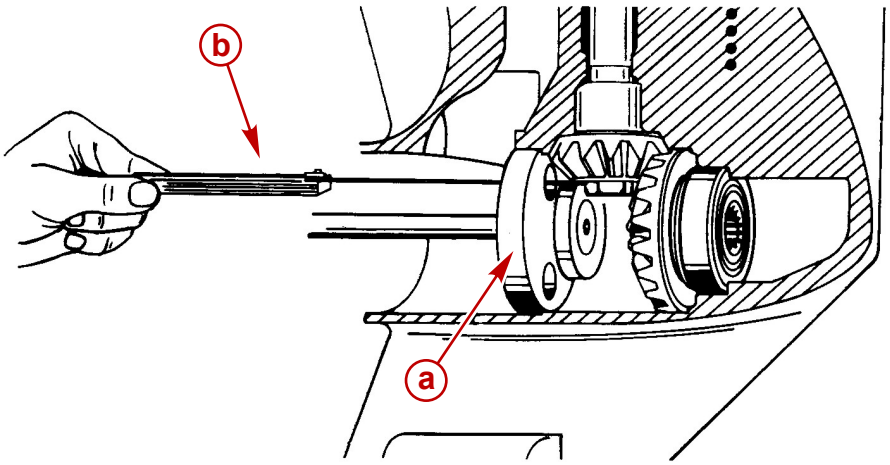
20292

a - Dial-type (lb. in.) torque wrench **b -** Drive shaft adaptor

Pinion Gear Location Shimming/Setup Procedure

IMPORTANT: Drive shaft bearing preload must be to specification before checking the pinion gear location (height).

1. Check pinion height.
   a. Insert shimming tool into gear housing.
   b. Measure clearance between shimming tool and gear with feeler gauge. Clearance must be set to specification. Take measurement at 3 locations on gear (120 degrees apart).

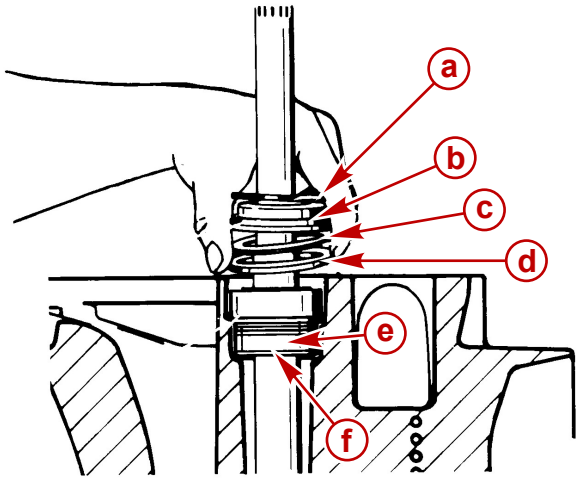


20293

a - Driveshaft Pinion Gear Shimming Tool
b - Feeler gauge

Driveshaft Pinion Gear Shimming Tool	91-42840T

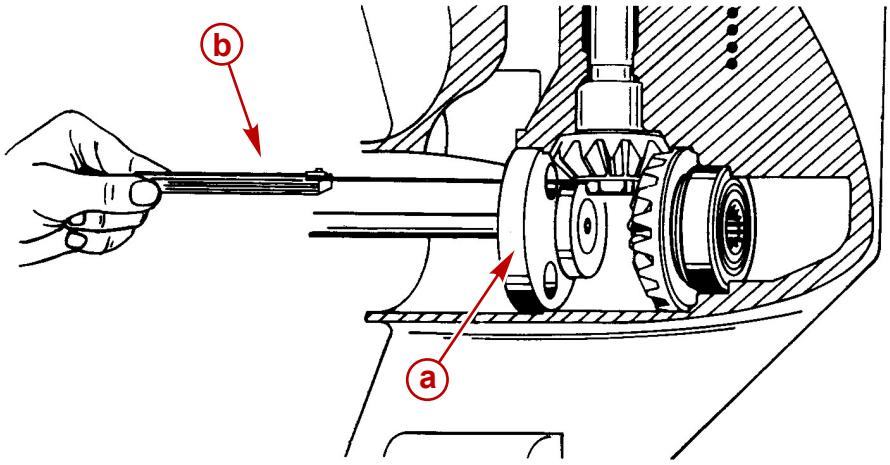
2. If clearance is less than specified: Add appropriate thickness of shim(s) under lower tapered roller bearing cup. **Any thickness added here must be subtracted from shim thickness at upper bearing.** If clearance is more than specified: Remove appropriate thickness of shim (s) from under lower tapered roller bearing cup. **Any thickness subtracted here must be added to shim thickness at upper bearing.**



20392

a - O-ring
b - Spacer
c - Shims, upper
d - Tab washer
e - Bearing cup, lower
f - Shims, lower

3. Recheck clearance after changing shim(s) in previous step.



20293

a - Driveshaft Pinion Gear Shimming Tool
b - Feeler gauge

4. Recheck rolling torque (preload) before proceeding to setting propeller shaft preload. Adjust, if necessary, to attain proper reading.

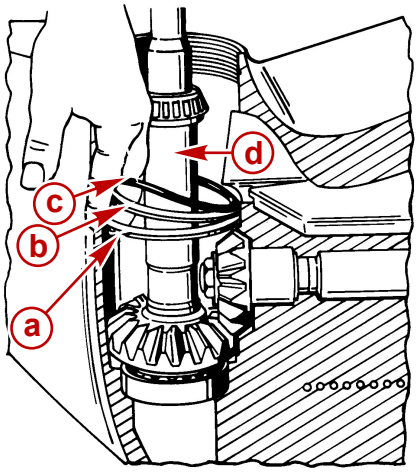
Driven Gear Lash Shimming/Setup Procedure

NOTE: *Models with shims in front of the bearing carrier can be upgraded to a load ring per Service Bulletin 93-10.*

NOTE: *When switching to a load ring, in an older gear housing that was using shims, some housings will cause the tab on the tab washer to bend as the bearing carrier retainer nut is tightened to get the proper rolling torque (preload). The round tab hole in the older cases may not have enough clearance to allow some forward movement of the tab as the bearing carrier retainer nut is tightened.*

Newer cases have an elongated tab hole to permit this forward movement without bending the tab. If you find that excess torque is required to get the proper rolling torque preload (more than 339 Nm (250 lb. ft.)), or if there are signs of the tab being deformed, then order a Tabless Spacer Washer (14-863195) and place it under the tab washer. This spacer washer may also be required on some early load ring gearcases.

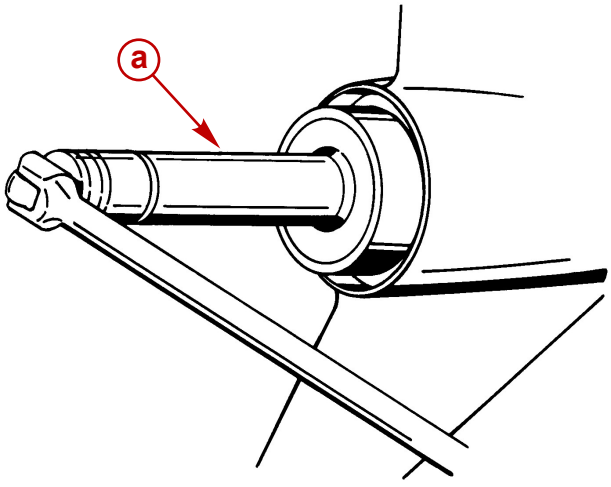
1. Install the original load ring, thrust ring, and O-ring into the gear housing.



20295

a - Load ring
b - Thrust ring (.105 in. thickness)
c - O-ring
d - Propeller shaft

2. Install the bearing carrier and tab washer in the gear housing.
3. Lubricate threads on bearing carrier retainer with Special Lubricant 101 and then install and tighten bearing carrier retaining nut until no more end-play can be felt (to preload bearings). Then tighten bearing carrier retainer nut enough to make propshaft hard to turn - to assist when making gear lash check. **Do not over-torque.**



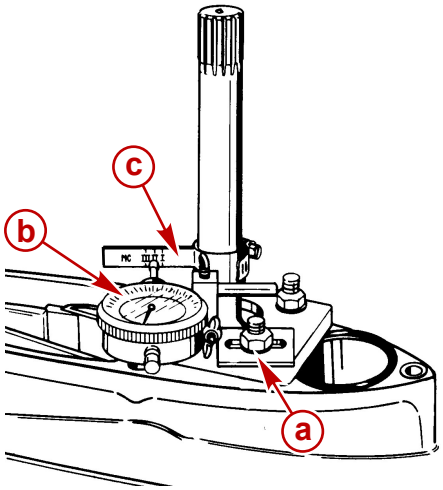
20296

a - Bearing Carrier Retainer Nut Wrench

Bearing Carrier Retainer Nut Wrench	91-61069T

4. **Driven gear shimming.**

a. Install the following special tools: Dial Indicator Adapter, Backlash Indicator Rod, and Dial Indicator, as shown. Ensure dial rod is aligned with "II" on indicator rod and that dial rod and indicator rod are at exactly 90 degrees to each other.



20297

a - Dial Indicator Adapter
b - Dial Indicator (positioned at 90 degrees to indicator rod)
c - Backlash Indicator Rod

Dial Indicator Adapter	91-83155

Backlash Indicator Rod	91-53459

Dial Indicator	91-58222A1

b. Check gear backlash by lightly rotating drive shaft back and forth. Do not allow propeller shaft to turn. Observe dial indicator and record the reading.

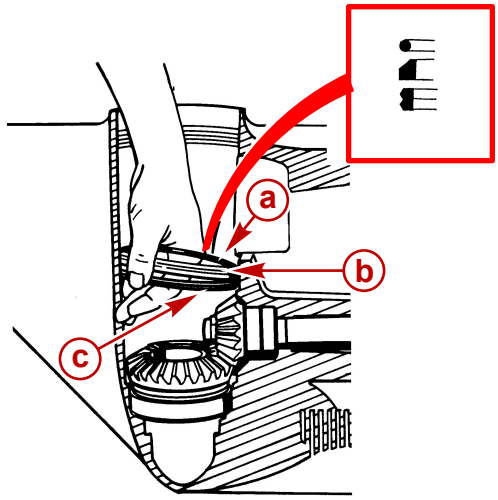
NOTE: *For a more definite feel of the gear lash, channel-lock pliers can be used to grip the drive shaft splines while rotating shaft to determine amount of play.*

c. If backlash is not correct, disassemble and proceed as follows. If backlash is **more** than specified: **Add** shim(s) under driven gear bearing cup. If backlash is **less** than specified: **Subtract** shim(s) under driven gear bearing cup.

5. When lash is correct, perform final prop shaft rolling torque (preload) adjustment.

Checking/Adjusting Final Propeller Shaft and Overall Gear Housing Bearing Preload (Rolling Torque)

1. Remove bearing carrier and items shown.



20298

a - O-ring
b - Thrust ring
c - Load ring

IMPORTANT: Always use a new load ring when reassembling.

2. Install new load ring, original thrust ring and new O-ring.
3. Install bearing carrier and tab washer in gear housing (and Tabless Spacer Washer, 14-863195, if required).
4. Lubricate threads on bearing carrier retaining nut with Special Lubricant 101. Install, and tighten bearing carrier retainer until resistance to propeller shaft rotation can be felt (to preload bearings).
5. Tighten the retainer nut to achieve the proper overall gearcase preload. To determine overall gearcase preload, add prop shaft bearing preload to drive shaft preload as outlined in the following example.

Setting Overall Gear Housing Preload

IMPORTANT: The overall preload includes both the driveshaft preload and the propshaft preload.

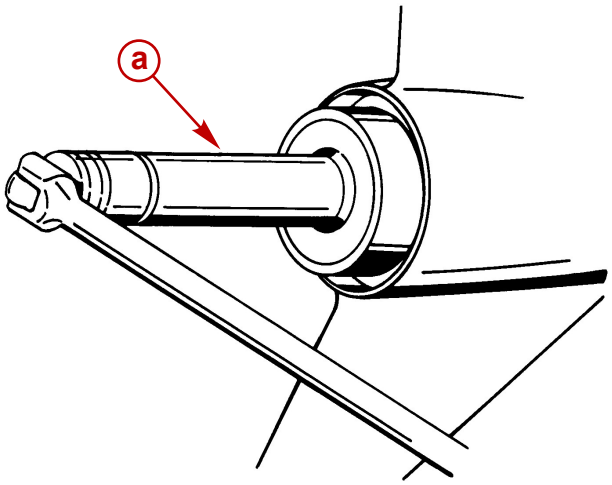
Preloads	
Propshaft new bearings	.9 - 1.4 Nm (8 - 12 lb. in.)**
Propshaft used bearings*	.6 - .9 Nm (5 - 8 lb. in.)**
Driveshaft	.3 - .6 Nm (3 - 5 lb. in.)
* Bearing is considered used if spun under load (with power applied).	
** Plus driveshaft preload [.3-6 Nm (3-5 lb. in.)]	

Example:

Driveshaft preload	.45 Nm (4 lb. in.)
	+
Propshaft (new bearing) preload	1.1 Nm (10 lb. in.)
Over-all preload	1.6 Nm (14 lb. in.)

OVERALL GEARCASE PRELOAD TABLE				
		Driveshaft preload		
		.3 Nm (3 lb. in.)	.45 Nm (4 lb. in.)	.6 Nm (5 lb. in.)
Propeller shaft preload	.6 Nm (5 lb. in.)	.9 Nm (8 lb. in.)	1 Nm (9 lb. in.)	1.1 Nm (10 lb. in.)
	.68 Nm (6 lb. in.)	1 Nm (9 lb. in.)	1.1 Nm (10 lb. in.)	1.2 Nm (11 lb. in.)
	.8 Nm (7 lb. in.)	1.1 Nm (10 lb. in.)	1.2 Nm (11 lb. in.)	1.4 Nm (12 lb. in.)
	.9 Nm (8 lb. in.)	1.2 Nm (11 lb. in.)	1.4 Nm (12 lb. in.)	1.5 Nm (13 lb. in.)
	1 Nm (9 lb. in.)	1.4 Nm (12 lb. in.)	1.5 Nm (13 lb. in.)	1.6 Nm (14 lb. in.)
	1.1 Nm (10 lb. in.)	1.5 Nm (13 lb. in.)	1.6 Nm (14 lb. in.)	1.7 Nm (15 lb. in.)
	1.2 Nm (11 lb. in.)	1.6 Nm (14 lb. in.)	1.7 Nm (15 lb. in.)	1.8 Nm (16 lb. in.)
	1.4 Nm (12 lb. in.)	1.7 Nm (15 lb. in.)	1.8 Nm (16 lb. in.)	1.9 Nm (17 lb. in.)

6. Tighten the retainer nut to achieve the proper preload using the following procedure.
   a. Tighten the retainer nut in small increments.

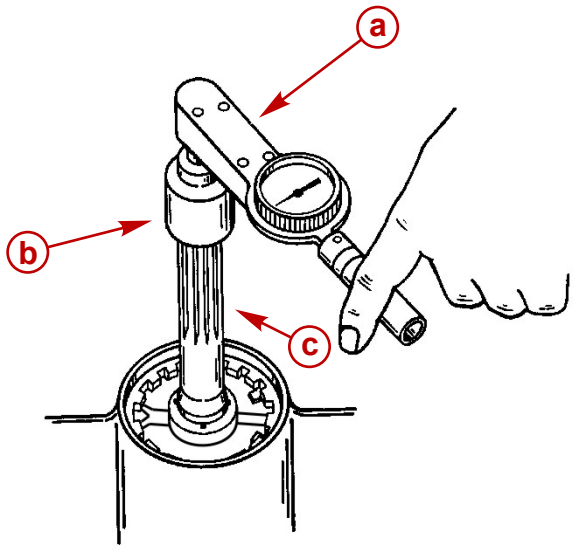


20296

a - Bearing Carrier Retainer Nut Wrench

Bearing Carrier Retainer Nut Wrench	91-61069T

b. After tightening retainer nut in small increments, check overall gear housing bearing preload at propeller shaft, each time, until correct specification is reached.



20302

a - Dial-type (lb. in.) Torque Wrench
b - Propeller nut (under socket)
c - Rotate shaft in direction of normal rotation using a smooth, steady motion

c. If you tighten the retainer past the overall preload, replace the load ring and start again at Step 2.

7. When proper overall preload is reached, bend the tab washer up into the retainer nut to secure it.

Major Differences Between The Bravo One And Bravo Two Gear Housing

- A larger bearing carrier retainer wrench tool is used (91-17257).
- The propshaft bearing carrier uses a locating key, like the older Alpha drives.
- The propshaft bearing carrier has a tapered roller bearing race (like a Bravo One) and a caged needle bearing (like the Alpha series). The bearings are serviced separately, but the roller bearing race is used to set the propshaft bearing preload and the caged needle bearing absorbs axial thrust loads. A Driver (91-55919) is used to press the needle bearing from the carrier (like an Alpha) and a different Driver (91-55918) is used to install the bearing. The tapered roller bearing race is removed with a slide hammer and installed with a Driver (91–63626), which is the same tool used to install the driven gear race.
- All Bravo Two units use a load ring. There are no shimmed bearing carriers. Propshaft rolling torque is still measured at the propshaft and must be .9-1.4 Nm (8-12 lb. in.) (new bearings) or .6-.9 Nm (5-8 lb. in.) (used bearings) above the driveshaft rolling torque of .3-.6 Nm (3-5 lb. in.), just like a Bravo One.
- A larger seal installer (91-55916) is used and the seals are pressed in from the outside (rear of the carrier).
- A larger bearing installer (91-63626) is used to press in the driven gear race. The shims under the cup are still used to set backlash.
- The vertical shaft and the pinion bearing are serviced in the same manner (and with the same tools) as the Bravo One, with the exception that on earlier units there are two different bearing part numbers, depending on the gearcase casting number (See Service Manual #11, 90-17431--4 [3/98], page 3C–15) .
- A larger Shimming Tool (91-96512) is used to set pinion height, but the specification is still 0.64 mm (0.025 in.).

- Backlash specification is 0.23-0.38 mm (0.009-0.015 in.), which is a little more forgiving than the Bravo One.

Bearing Carrier Retainer Tool	91-17257
Bearing Driver	91-55919
Bearing Driver	91-55918
Bearing Cup Driver	91-63626
Oil Seal Driver	91-55916
Gearcase Pinion Shimming Tool	91-96512

Bravo Drive Unit Service

Section 8E - Bravo Three Gear Housing Setup

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Propeller Shaft Spline Lash Check (Bravo Three Only) 2
Bravo Three Backlash Shimming/Setup Procedure 3

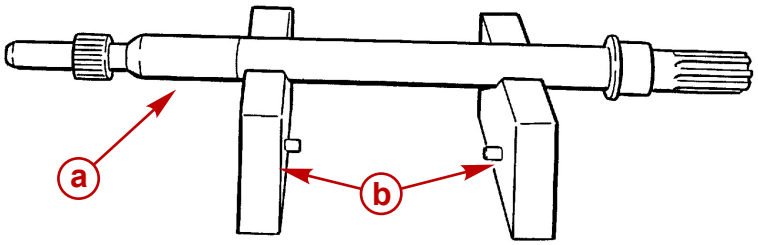
8E

Bravo Three Gear Housing Activity

The object of the activity is to review and/or perform the subjects titled in Service Manual # 28 and answer the related questions on the activity sheet.

Propeller Shaft Spline Lash Check (Bravo Three Only)

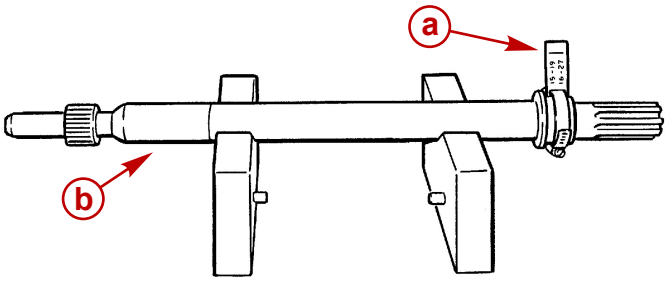
1. Check inner propeller shaft spline lash as follows:
   a. Place inner propeller shaft on two V-blocks.



20304

a - Inner propeller shaft
b - V-blocks

   b. Install Spline Backlash Tool on inner propeller shaft, just behind shaft spline.

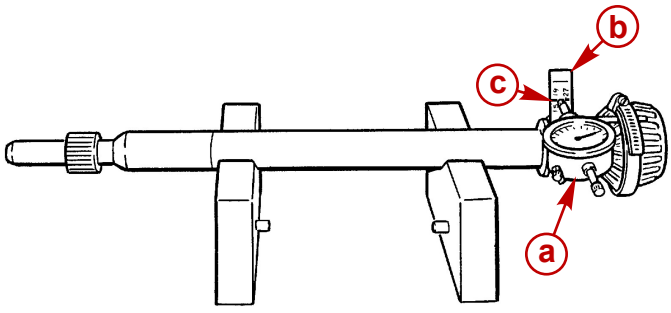


20305

a - Spline Backlash Tool
b - Inner propeller shaft

Spline Backlash Tool	91-806192

   c. Slide front driven gear assembly onto spline of inner propeller shaft.
   d. Mount Dial Indicator to gear and position so that indicator probe aligns with mark on Indicator Rod.



20311

a - Dial Indicator
b - Spline Backlash Tool
c - Mark stamped on Indicator Rod

Spline Backlash Tool	91-806192

Dial Indicator	91-58222A1

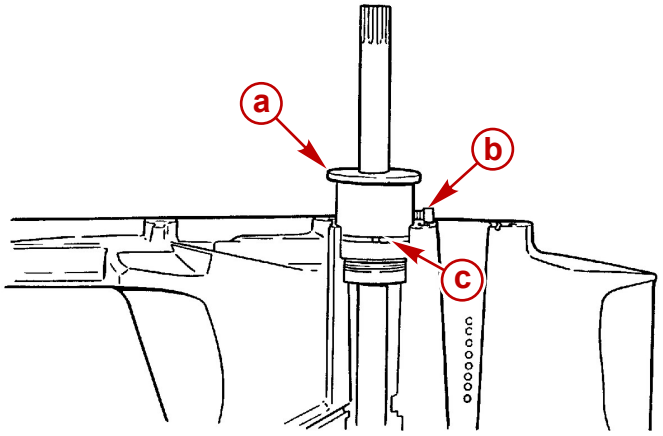
e. Rotate gear back and forth, while observing dial indicator. Record spline lash reading (for use later in this section). This reading is required to determine true backlash between pinion and driven gear.

2. Check outer propeller shaft spline lash following the same procedures as for the inner propeller shaft listed in Steps **"a"** through **"e"** above using Spline Backlash tool.

Bravo Three Backlash Shimming/Setup Procedure

1. **Front driven gear shimming.**

   a. Remove clamp plate, O-ring, spacer and shim(s), and place drive shaft retaining tool on tab washer as shown. Do not tighten locking bolt at this time.



20312

a - Driveshaft Retaining Tool (1999 and prior, 91-805381 / 2000 and Newer, 91-863738)
b - Locking bolt
c - Tab washer

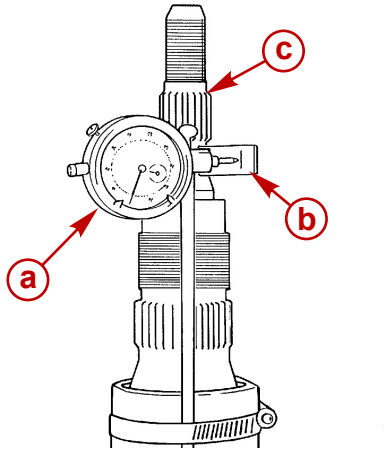
Driveshaft Retaining Tool	91-805381

Driveshaft Retaining Tool	91-863738

   b. Position gear housing so that propeller shafts are facing up in the vertical position. Rotate propeller shafts several times to seat bearings prior to making checks.

   c. Lightly press down on Driveshaft Retaining Tool, while simultaneously turning shaft, to ensure bearings are seated in bearing cups, then tighten locking bolt to retain drive shaft.

d. Install Backlash Indicator Rod to inner propeller shaft as shown. Mount Dial Indicator to bearing carrier and position probe on mark stamped in Indicator Rod.



20313

a - Dial Indicator
b - Spline Backlash Tool
c - Inner propeller shaft

NOTE: *Dial Indicator Rod and Backlash Indicator Rod should be at exactly 90 degrees to each other.*

Dial Indicator	91-58222A1

Spline Backlash Tool	91-806192

NOTE: *For a more definite feel of the gear lash, channel-lock pliers can be used to grip the drive shaft splines while rotating shaft to determine amount of play.*

e. Check total backlash by lightly rotating inner propeller shaft back and forth. Observe dial indicator and record reading.

f. Subtract the gear/shaft spline lash reading (obtained from Propeller Shaft Spline Lash Check performed earlier) from total backlash reading. Actual gear backlash should be between 0.3-0.4 mm (.012-.016 in.).

Example:

Total backlash reading:	0.75 mm (.030 in.)
Minus	–
Gear/Shaft spline lash (from propeller shaft spline lash check):	0.4 mm (.016 in.)
Equals	=
Actual gear backlash:	0.35 mm (.014 in.)

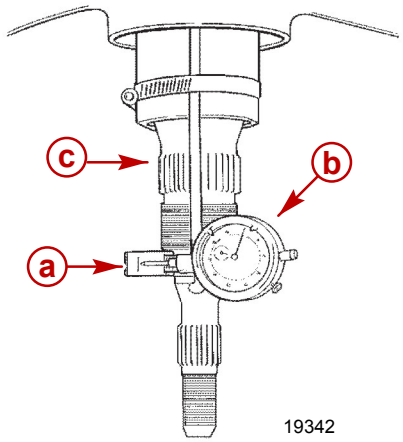
g. If backlash is not correct, disassemble and proceed as follows: If backlash is more than specified, add shims behind front driven gear bearing cup. If backlash is less than specified, remove shims from behind front driven gear bearing cup.

h. Recheck backlash reading after reassembly.

2. **Rear driven gear shimming.**

a. Position gear housing so that propeller shafts are facing down in the vertical position. Loosen locking bolt on drive shaft retaining tool and rotate propeller shafts several times to seat bearings prior to making checks. Lightly press down on drive shaft retaining tool to ensure bearings are seated in bearing cups, then tighten locking bolt to retain drive shaft.

b. Install Spline Backlash Tool to outer propeller shaft as shown. Mount Dial Indicator to bearing carrier and position probe on mark stamped in Indicator Rod.



a - Spline Backlash Tool
b - Dial Indicator
c - Outer propeller shaft

Spline Backlash Tool	91-806192

Dial Indicator	91-58222A1

c. Check total lash by lightly rotating outer propeller shaft back and forth. Observe dial indicator and record reading.

d. Subtract the gear/shaft spline lash reading (obtained from **Propeller Shaft Spline Lash Check**, performed earlier) from total backlash reading. Actual gear backlash should be between 0.3-0.4 mm (.012-.016 in.).

Example:

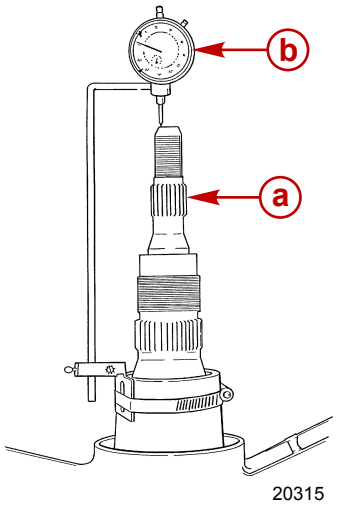
Total backlash reading:	0.75 mm (.030 in.)
Minus	–
Gear/Shaft spline lash (from propeller shaft spline lash check):	0.4 mm (.016 in.)
Equals	=
Actual gear backlash:	0.35 mm (.014 in.)

e. If backlash is not correct, disassemble and proceed as follows: If backlash is more than specified, remove shims from in front of rear driven gear bearing cup. If backlash is less than specified, add shims in front of rear driven gear bearing cup.

f. Recheck backlash reading after reassembly.

3. **Check propshaft end play.**

a. Install Dial Indicator on propshaft as illustrated below. Move inner shaft up and down while reading Dial Indicator (ensure outer shaft is also being lifted by inner shaft). If reading is outside of range, the outer propeller shaft thrust race shims must be increased or decreased to bring the end-play reading within range of specifications.



a - Inner propeller shaft **b -** Dial Indicator

Specification Range	
End-Play Range	0.03-0.30 mm (.001-.012 in.)

Dial Indicator	91-58222A1

4. Remove Driveshaft Retaining Tool and reinstall shim(s), spacer and O-ring.

Bravo Drive Unit Service

Section 8F - Bravo Shift Cable Installation, Drive Unit Installation and Shift Setup

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Replacing Earlier Model Bravo Shift Cables with Later Model Shift Cables.....2
Bravo Drive Unit Shift Cable Installation.....4
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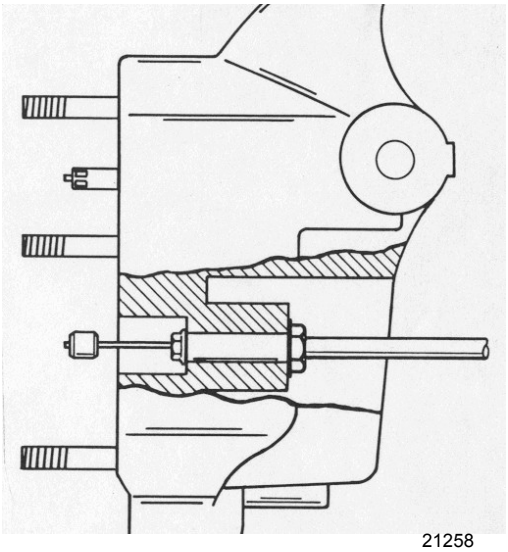
Bravo Drive Unit Remote Control and Drive Unit Shift Cable Adjustment.....15
Changes to Shift Plate Assembly - 2003.....19

8F

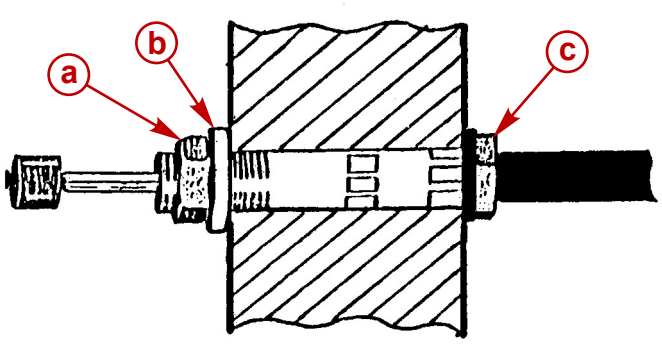
Replacing Earlier Model Bravo Shift Cables with Later Model Shift Cables

Models with earlier style shift cable – identified by small nut which will not pass over cable anchor - core wire must be pulled from shift cable to remove cable assembly from bell housing.



21258

Models with later style shift cable – identified by larger nut which fits over core wire anchor; it is unnecessary to remove core wire to remove shift cable assembly.



21261

a - Shift cable retaining nut
b - Washer
c - Inside nut

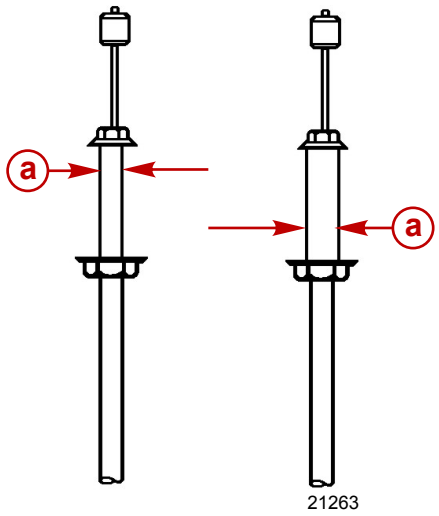
To install the later model shift cable on all Bravo transom assemblies with serial number OD542204 and lower you must enlarge the bell housing shift cable retainer hole from 9.53 mm (3/8 in.) to 11.11 mm (7/16 in.) . Use the Bravo Shift Cable Replacement Kit (815471A3).

All Bravo Transom Assemblies, serial number OD542205 and above, already have the latest style shift cable.

Shift Cable Inspection and Upgrade

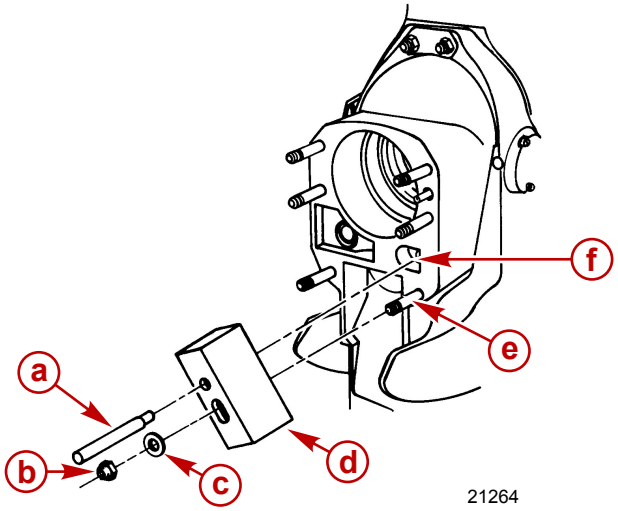
1. Remove the sterndrive unit.
2. Compare the shift cable that was removed from the unit with the replacement shift cable.
   a. If cable diameter **a** is equal on both the removed cable and the replacement cable, then both cables are the later model. Install the replacement cable (skip Steps 3-8 and go to **Bravo Drive Unit Shift Cable Installation**).

b. If cable diameter **a** is larger on the replacement shift cable than on the removed shift cable, proceed with the following instructions.



a - Cable diameter

3. Slide the slotted hole of the Drill Bushing Tool over the lowest stud closest to the bell housing shift cable bore.
4. Install the alignment rod through the round 11.11 mm (7/16 in.) hole of the bushing tool and into the bell housing shift cable bore. Make sure that it is seated fully into the bore.
5. Clamp the drill bushing tool into place using one of the nuts and washers that hold the sterndrive unit to the bell housing.

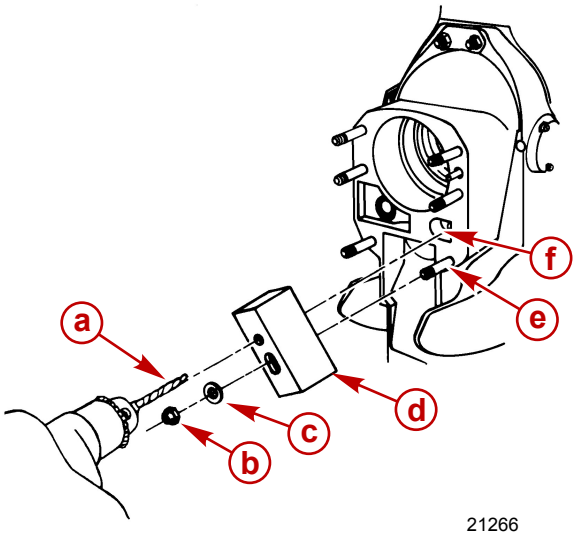


a - Alignment rod
b - Nut
c - Washer
d - Drill Bushing Tool
e - Bell housing stud
f - Bell housing shift cable bore

⚠ CAUTION

Water leakage could cause premature shift component failure. Using the wrong drill may create a rough surface in the shift cable bore, allowing water leakage. Use a sharp, straight drill with a 118° point and without nicks.

6. Drill through the 11.11 mm (7/16 in.) hole in the Drill Bushing Tool and through the bell housing shift cable bore. Use the 11.11 mm (7/16 in.) drill provided in Service Tool Kit 91-818836A-1.



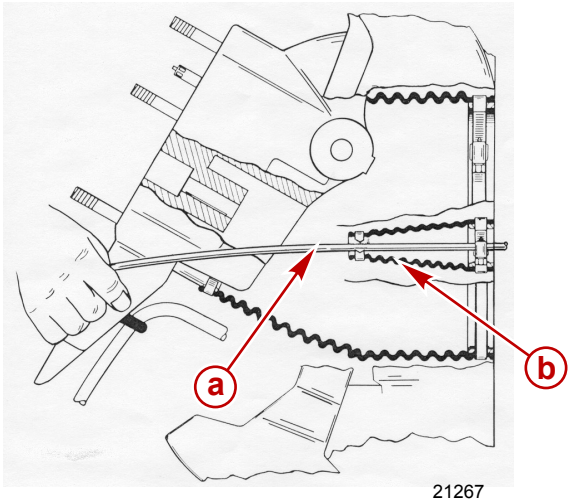
21266

a - Drill
b - Nut
c - Washer
d - Drill Bushing Tool
e - Bell housing stud
f - Bell housing shift cable bore

7. Remove the drill bushing tool and clean the debris out of the bell housing. Apply 2-4-C Marine Lubricant with Teflon to the newly drilled hole.
8. Install the new shift cable.

Bravo Drive Unit Shift Cable Installation

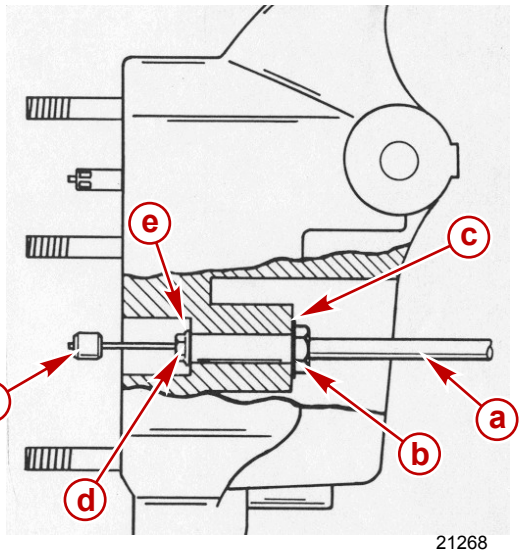
1. Insert shift cable end into and through shift cable bellows.



21267

a - Shift cable end
b - Shift cable bellows

2. Apply Perfect Seal to shift cable retaining nut threads. Secure shift cable to bell housing. Hold inner nut with wrench and torque outer retaining nut to specifications.

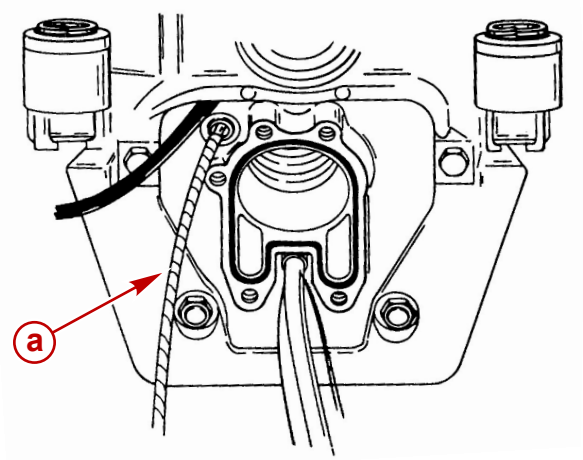


21268

a - Shift cable
b - Inner nut
c - Seal washer (hidden by nut)
d - Outer retaining nut
e - Later style cable - washer
f - Core wire is in later model cable, only (at this step of reinstallation)

Description	Nm	lb. in.	lb. ft.
Outer retaining nut	7	65	

3. Install shift cable wrapping.



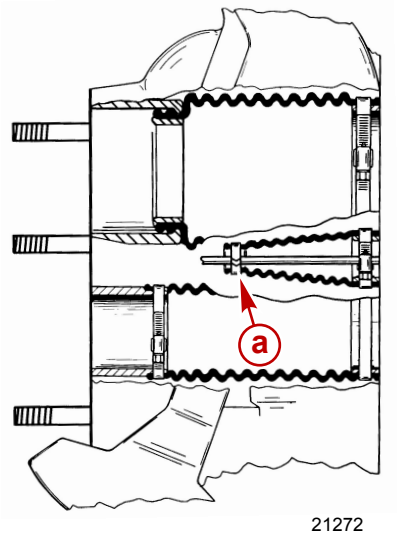
21270

a - Shift cable wrapping

⚠ CAUTION

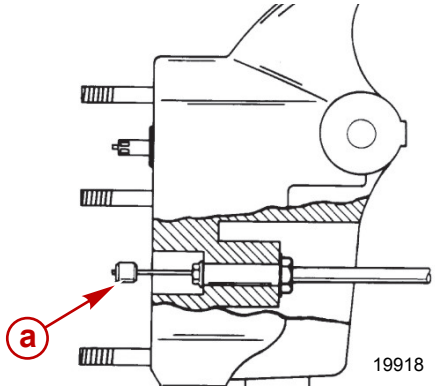
Water leakage into the bilge may result if the shift cable bellows crimp clamp is not installed properly. Check that bellows end is not flattened out when crimping. Installation tool information is found in drive unit service manual.

4. Install and compress shift cable bellows crimp clamp, maintaining a 12.7 mm (1/2 in.) diameter **round** O.D. Ensure that clamp is crimped evenly so that a good seal is maintained between bellows and shift cable. (Do not allow bellows to flatten.)



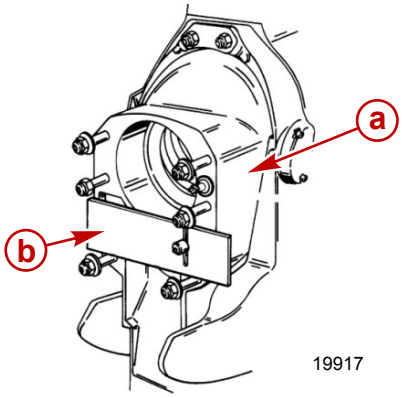
a - Crimp clamp

5. **Models with earlier shift cable -** install inner core wire.



a - Inner core wire

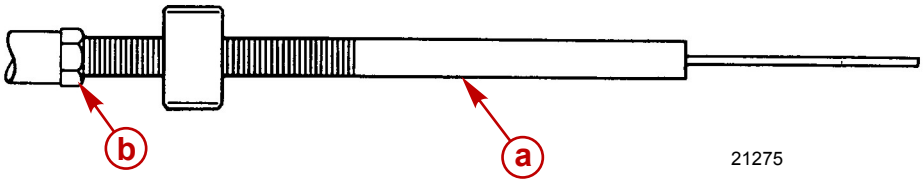
6. Install Core Wire Locating Tool on face of bell housing.



a - Bell housing **b -** Core Wire Locating Tool

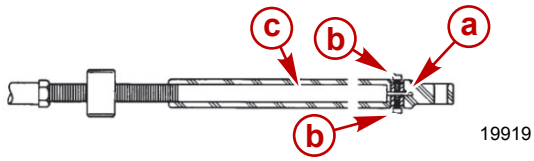
Shift Cable Anchor Adjustment Tool	91-17262A1

7. Install threaded tube until it bottoms out. Tighten finger tight. Tighten jam nut securely.



a - Threaded tube **b -** Jam nut

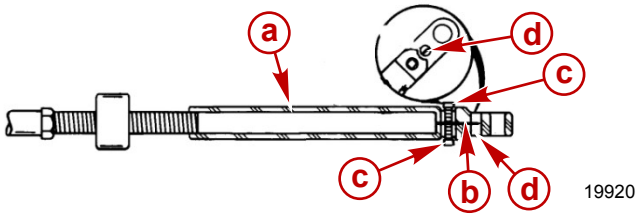
8. Earlier shift cables with support tubes - discard support tube; do not reinstall.
9. Install cable end guide over core wire, and insert core wire through cable anchor. Tighten anchor screws evenly and torque to specification.



Earlier Models

a - Core wire
b - Anchor screws
c - Cable end guide

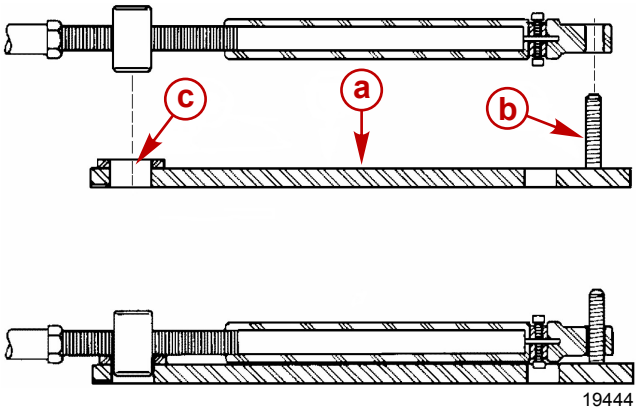
Description	Nm	lb. in.	lb. ft.
Anchor screws	2.3	20	



Later Models

a - Cable end guide
b - Core wire
c - Anchor screws
d - Sight port - bottom-out core wire (present on all later style and some earlier style cables)

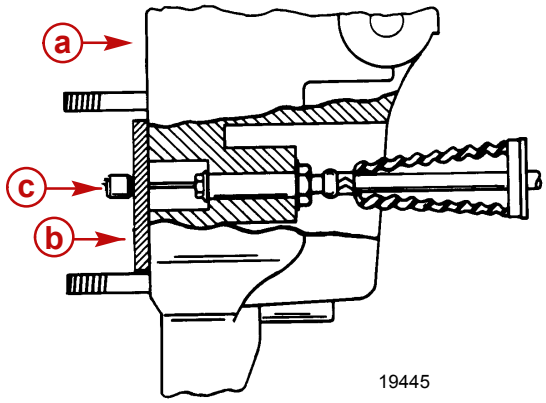
10. Place Shift Cable Anchor Adjustment Tool on end of shift cable as shown.



a - Shift Cable Anchor Adjustment Tool
b - Stud - placed through hole in end guide
c - Hole - barrel placed here

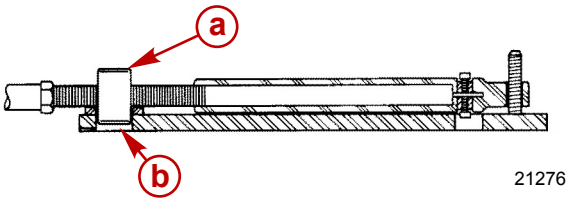
Shift Cable Anchor Adjustment Tool	91-17262A1

11. Ensure that bell housing end of core wire is positioned tightly against Core Wire Locating Tool.



a - Bell housing
b - Core Wire Locating Tool
c - Core wire

12. Adjust cable barrel to align with hole in tool. Remove tools and install cable on shift plate assembly, being careful not to lose adjustment.

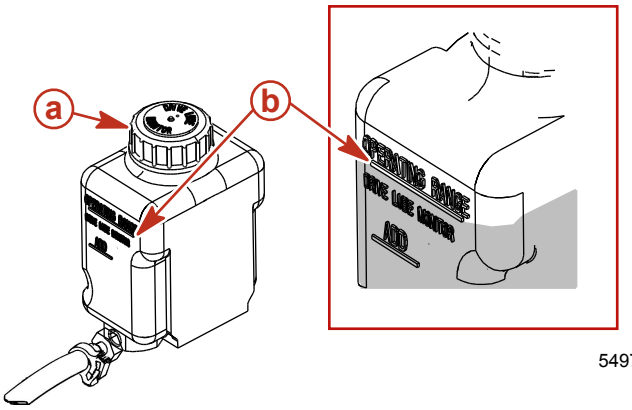


a - Barrel
b - Hole in tool

Bravo Sterndrive Unit Installation

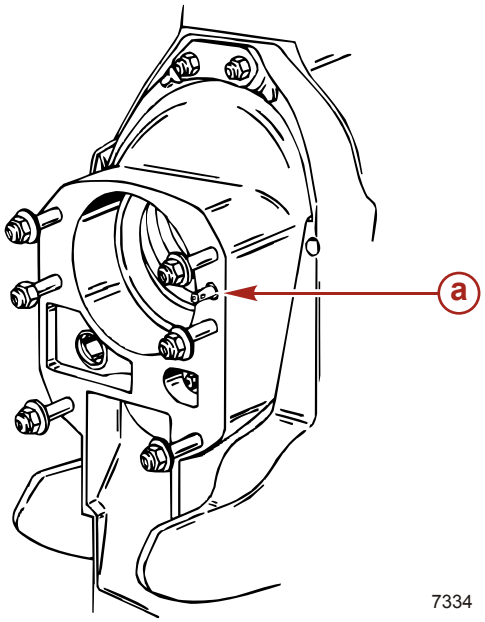
1. Remove trim cylinder support and dust cover from bell housing studs. (Retain elastic stop nuts and flat washers.)

2. Remove monitor cap and fill gear lube monitor.



a - Gear lube monitor cap **b -** Fluid level full mark

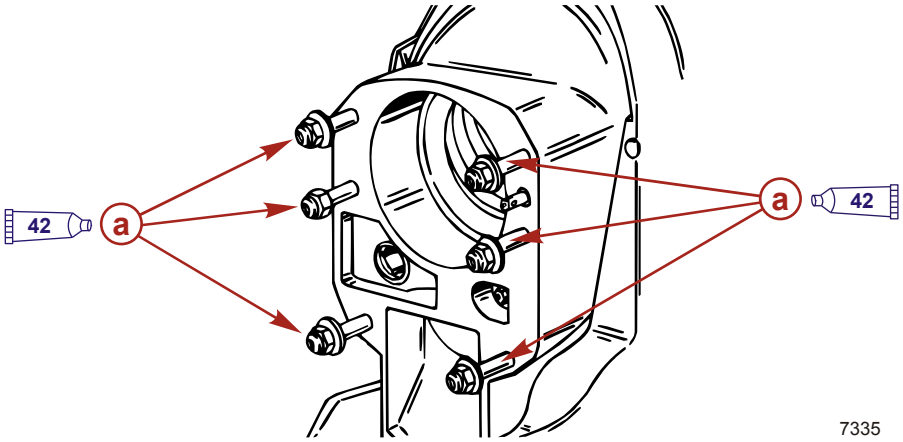
3. Push in on dribble valve until gear lube appears.



a - Dribble valve

4. Once gear lube appears, release dribble valve.
5. Fill monitor to "FULL" mark.
6. Replace monitor cap.

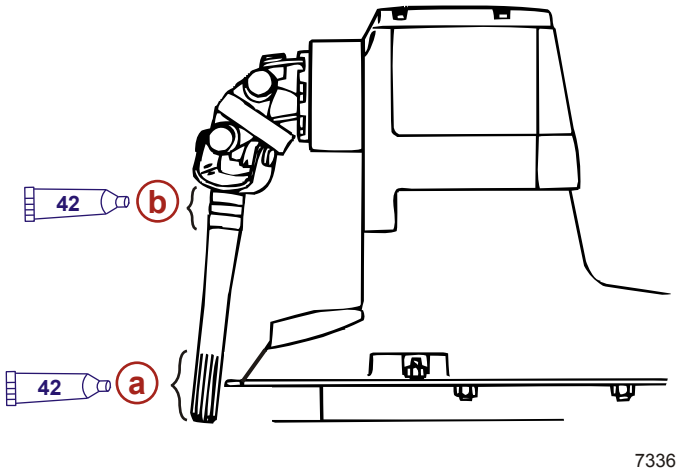
7. Apply 2-4-C Marine Lubricant with Teflon to studs.



a - Studs

Tube Ref No.	Description	Where Used	Part No.
42	U-joint and Gimbal Bearing Grease	Studs	92-802870A1

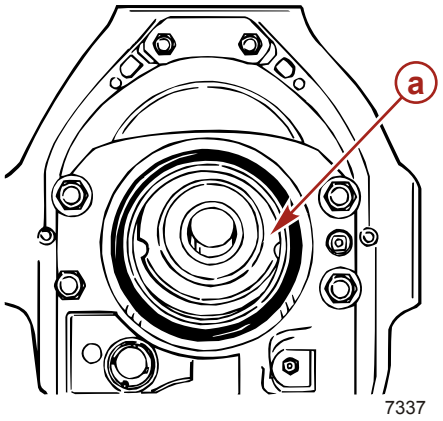
8. Lubricate U-joint shaft splines and U-joint shaft O-rings with Quicksilver Engine Coupler Spline Grease.



a - Splines **b -** O-rings

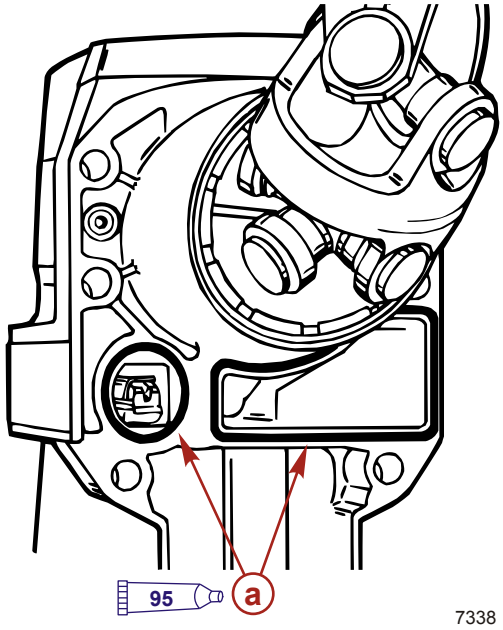
Tube Ref No.	Description	Where Used	Part No.
42	U-joint and Gimbal Bearing Grease	Shaft splines and O-rings	92-802870A1

9. Check drive shaft bellows for cleanliness and absence of debris.



a - Driveshaft bellows

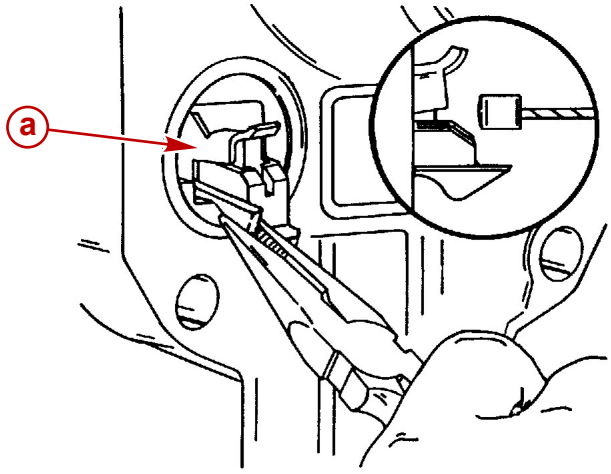
10. Lubricate O-ring seals with 2-4-C Marine Lubricant with Teflon.



a - O-ring seals

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	O-ring seals	92-802859A1

11. Pull out shift linkage as far as it moves. Jaws will open, as shown.

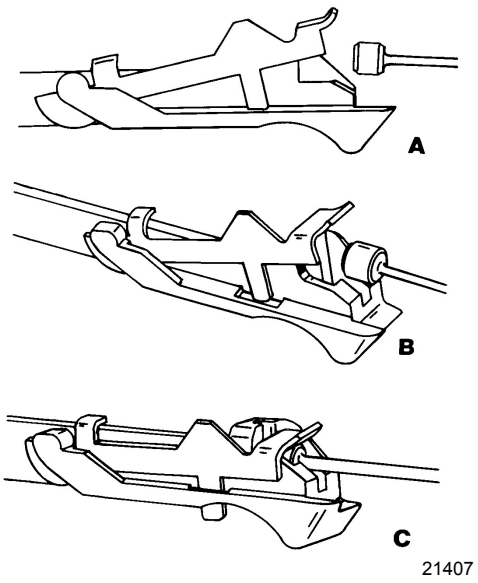


a - Shift linkage

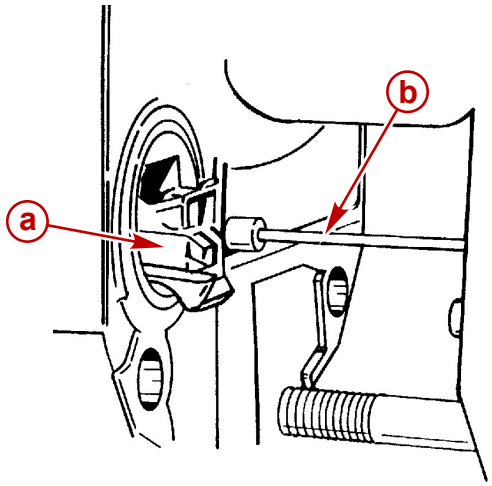
IMPORTANT: As sterndrive is inserted into drive unit, entry of the bell housing shift cable must be closely checked to make sure cable enters the jaws of shift linkage assembly in the sterndrive.

12. Place remote control in neutral position.

NOTE: *As bell housing shift cable enters the shift linkage assembly, it pushes the assembly back into the sterndrive housing, and the jaw closes, securing the cable, as shown in steps "A", "B" and "C".*

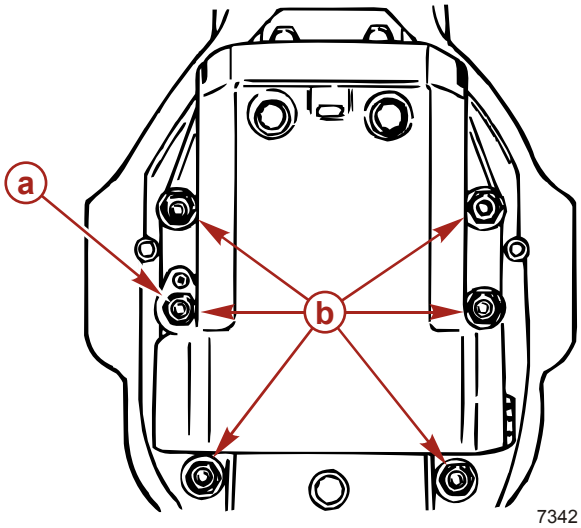


IMPORTANT: If bell housing shift cable "b" does not line up to properly enter jaws of shift linkage assembly "a", cable will have to be aligned manually.



a - Shift linkage assembly **b -** Shift cable

13. Place driveshaft housing in position on bell housing and install drive unit, as follows:
    a. Position trim cylinders so they point straight backwards.
    b. Position drive unit so that U-joint shaft aligns with bell housing bore.
    c. Guide U-joint shaft through bearing in gimbal housing and into engine coupler. Make sure that shift linkage jaws engage the bell housing shift cable assembly.
    d. If necessary, rotate propeller shaft counter-clockwise slightly (using a propeller) to align U-joint shaft splines with splines in engine coupling, then slide drive unit all the way into bell housing.
14. Secure drive unit to bell housing with 5 flat washers and 6 locknuts. Torque to specification.

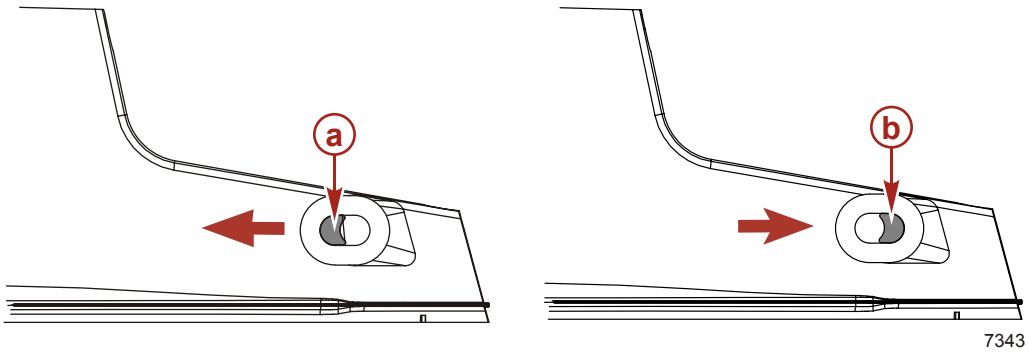


a - Do not install flat washer here
b - Elastic stop nuts (6) and flat washers (5)

Description	Nm	lb. in.	lb. ft.
Locknuts	68		50

IMPORTANT: On Bravo One, Two and Three models, the Trim-In Limit Pin (if equipped) must be properly positioned before installing the trim cylinder anchor pin in the following steps.

15. Ensure that the Trim-In Limit Pin is positioned as shown for the appropriate Bravo model.

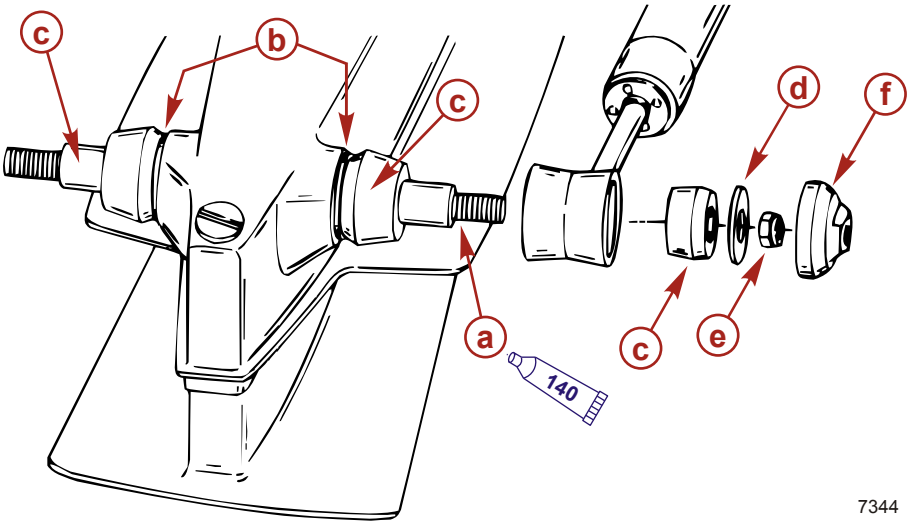


a - Trim-In Limit Pin for Bravo One and Two (positioned forward)
b - Trim-In Limit Pin for Bravo Three (positioned aft)

IMPORTANT: The position of the Trim-In Limit Pin on the Bravo Three sterndrive unit should only be changed after the boat has been properly tested.

IMPORTANT: To aid in installing rubber bushings, use a water and soap solution. Do not use oil or grease.

16. Install trim cylinders on aft end of drive unit with hardware as shown. Lubricate anchor pin threads with 2-4-C Marine Lubricant with Teflon and tighten nuts until they bottom. Install plastic caps and tighten hand tight only.

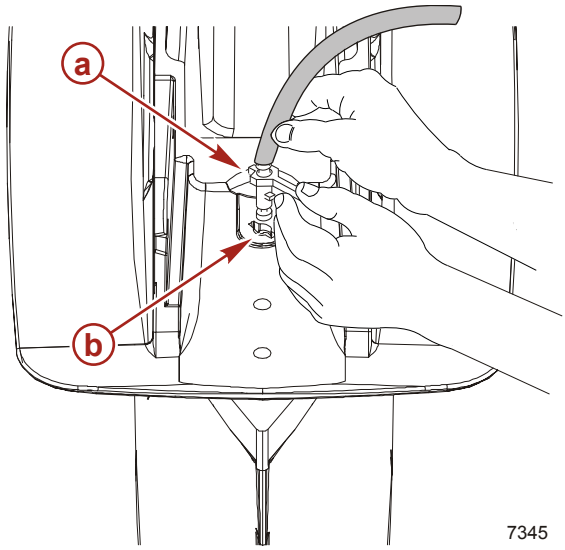


a - Aft anchor pin
b - Large I.D. flat washers (2)
c - Rubber bushings (4)
d - Small I.D. flat washers (2)
e - Locknuts (2)
f - Plastic caps (2)

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with Teflon	Anchor pin threads	92-802859A1

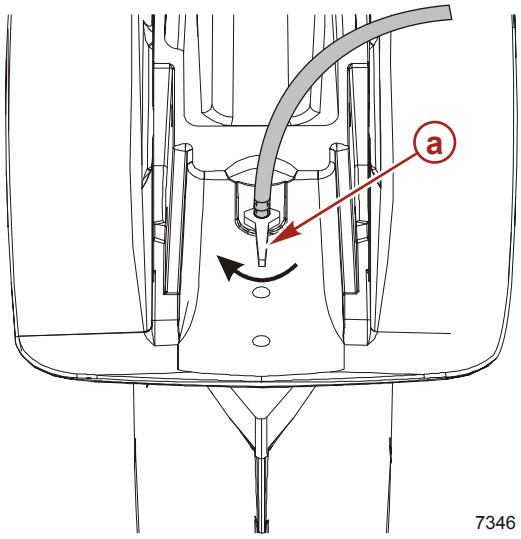
17. Raise drive to gain access to area between gimbal housing and sterndrive, and locate the opening in the forward end of the anti-ventilation plate.

18. Insert speedometer tube fitting into opening on topside of anti-ventilation plate, in position shown.



a - Speedometer hose fitting **b -** Opening

19. With fitting fully seated, turn handle clockwise to a tightly seated position, as shown.



a - Fitting installed (handle pointing forward)

Bravo Drive Unit Remote Control and Drive Unit Shift Cable Adjustment

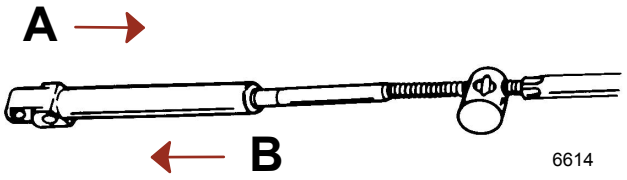
NOTE: *Bravo Models only: Using Shift Cable Adjustment Tool , shift cables can be adjusted without or with the sterndrive installed, using the following procedure.*

Shift Cable Adjustment Tool	91-12427

IMPORTANT: Sterndrive unit propeller rotation is determined by the shift cable installation in the remote control.

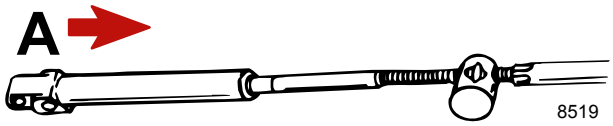
- Bravo One/Two - If shift cable end guide moves in direction "A" when control lever is placed in **forward**, remote control is set up for **right-hand (RH)** propeller rotation.

- Bravo One/Two - If shift cable end guide moves in direction "B" when control lever is placed in **forward**, remote control is set up for **left-hand (LH)** propeller rotation.



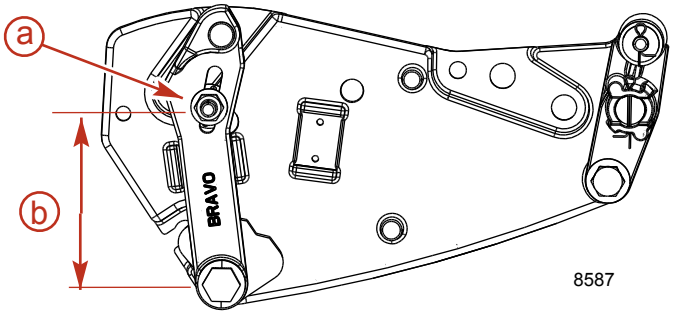
Arrow indicates direction of motion

- Bravo Three - Front propeller on sterndrive unit is always **LH** rotation and rear propeller is always **RH** rotation. Shift cable end guide must move in direction "A," when control lever is placed in **forward** gear position.



IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do not fasten any items to shift cables.

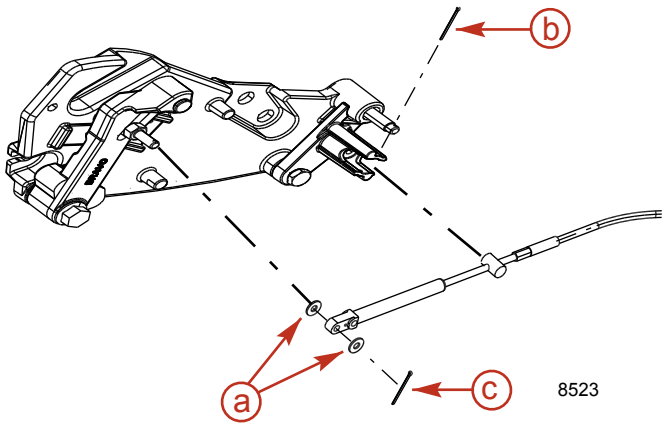
1. Loosen the adjustable stud and move it to dimension, as shown. Retighten stud.



Typical Bravo shift bracket shown without switch

a - Adjustable stud
b - 76 mm (3 in.) (center of pivot bolt to center of stud)

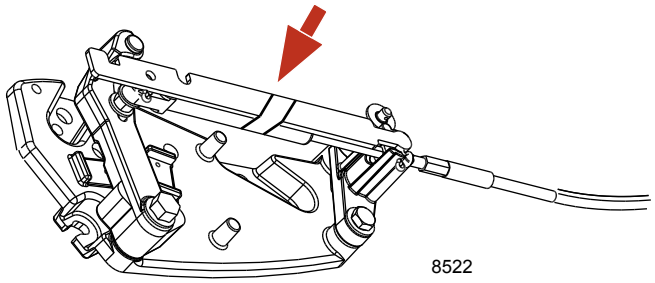
2. Install sterndrive unit shift cable.
3. Install cotter pin.
4. Insert cotter pin from top and spread ends fully.



Typical Bravo shift bracket shown without switch

a - Washers (2)
b - Long cotter pin
c - Short cotter pin

5. Place adjustment tool over sterndrive unit shift cable, as shown. Hold tool in place using a piece of tape over the barrel retainer.



Typical Bravo shift bracket shown without switch

6. Locate center of remote control and control cable play (backlash).

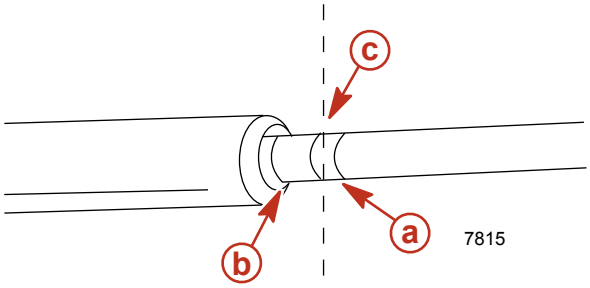
IMPORTANT: Keep center mark "c" aligned with control cable end guide edge when making the following adjustment.

a. Shift remote control to **neutral**.

b. Push in on control cable end with enough pressure to remove play and mark position "a" on tube.

c. Pull out on control cable end with enough pressure to remove play and mark position "b" on tube.

d. Measure distance between marks "a" and "b" and mark position "c" half-way between marks "a" and "b."

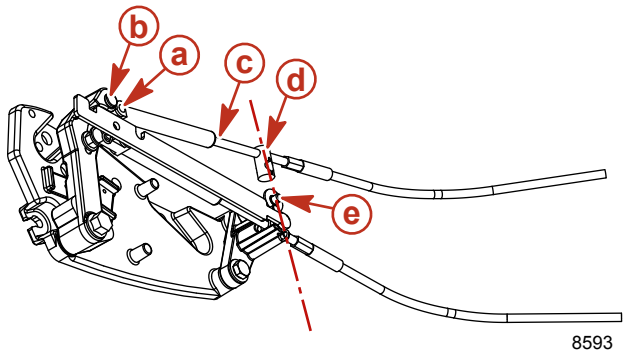


7. Temporarily install control cable end guide into shift lever and insert anchor (clevis) pin.
8. Adjust control cable barrel so that hole in barrel centers with vertical center line of stud. Ensure that backlash center mark is aligned with edge of control cable end guide.

⚠ CAUTION

Do not attempt to install or remove control cable barrel from stud without first removing end guide anchor pin from shift lever and removing cable. Attempting to bend control cable to install or remove barrel will place undue stress on cable end guide and shift lever and damage to both could occur.

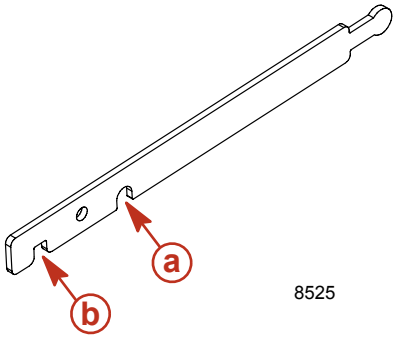
9. Remove control cable end guide from shift lever by removing anchor (clevis) pin.



Typical Bravo shift bracket shown without switch

a - Control cable end guide
b - Clevis pin (Anchor pin)
c - Backlash center
d - Control cable barrel
e - Stud

10. Install the control cable.
11. Install the washer and cotter pin to secure the barrel.
12. Install the clevis pin.
13. Install the cotter pin into the clevis pin from the top and spread the ends.
14. Remove the adjustment tool.
15. Shift remote control lever into **forward** position. Place end of adjustment tool in barrel retainer. If slot does not fit over stud, loosen shift lever stud and slide stud up or down until slot in tool fits over stud. When adjustment is correct, retighten stud.
16. Lift the adjustment tool so that the slot is above the stud.
17. Shift the remote control into **reverse** and repeat the adjustment process.

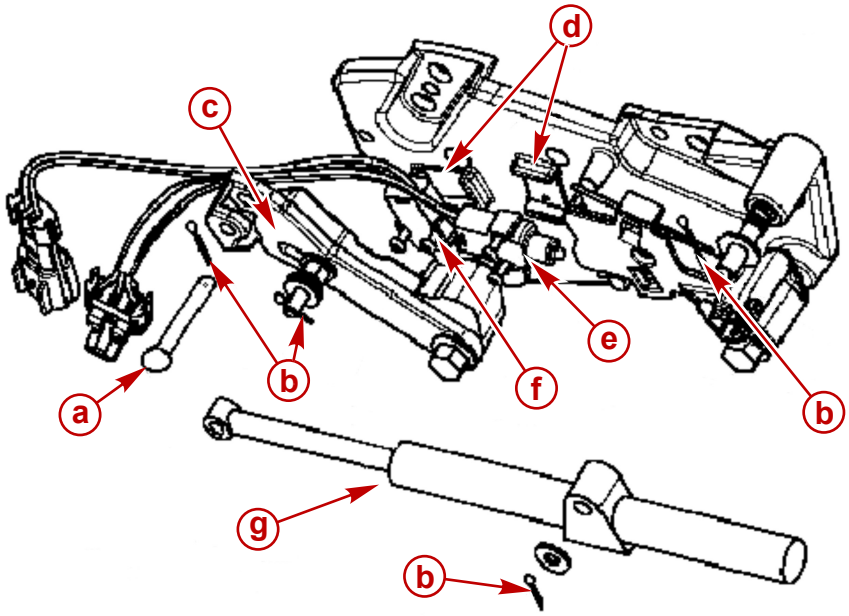


a - **RH** rotation Bravo One, Two, Three **forward**, **LH** rotation Bravo One and Two **reverse** slot
b - **LH** rotation Bravo One and Two **forward**, **RH** rotation Bravo One, Two and Three **reverse** slot

18. Remove adjustment tool.
19. Ensure that all cotter pins are secure and that the ends of the cotter pins are spread to 180 degrees.
20. Lubricate shift cable pivot points with 30W oil.

Changes to Shift Plate Assembly - 2003

Switch guide bosses added to hold switches in place when tightening mounting screws, switches have elongated screw slots for moving them to make the adjustment, studs and cotter pins replace threaded studs and nuts and shift levers modified.



21494

Alpha shift plate assembly (Bravo similar)

- **a -** Clevis pin
- **b -** Cotter pin
- **c -** Shift lever with dual detents
- **d -** Cast-in switch guide bosses
- **e -** Shift interrupt switch (Alpha only)
- **f -** Gear indicator switch (Alpha and Bravo)
- **g -** Shift assist assembly (Alpha only)

Dual gear indicator switch detents added so that lever can be moved from **run** position to **set** position for adjusting switch (lever moves out of the way of the adjusting screws and switch plunger can also be viewed). "ALPHA" and "BRAVO" stamped on individual levers for identification.

21499

New shift levers for Alpha and Bravo